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ON RECENT PROGRESS TOWARD THE SOLUTION OF PROBLEMS IN HYDRODYNAMICS.

IN this paper I shall not attempt to give an exhaustive account of the progress which has been made in hydrodynamics of recent years. Such an account, though possibly useful for purposes of reference, would be tedious and unsuitable for reading before an audience. I shall, therefore, try to give some idea of the general lines on which research has been carried on, laying stress on the more important discoveries and avoiding, as far as possible, mere technical details.

The choice of the period to be selected is not difficult. In 1846 Professor Stokes presented a report on the condition of hydrodynamics at that time, and this was continued by Professor Hicks in 1881–1882. Both these papers are printed in the reports of the British Association for the Advancement of Science. In the *Mathematische Annalen* for 1887 Mr. A. E. H. Love gave a summary of our knowledge of Vortex Motion, and Hicks practically carried this to the present day in his presidential address before Section A of the British Association in 1896. Professor Darwin's article on Tides in the Encyclopædia Britannica carries our knowledge of that subject to 1888. Hence I shall take the progress made in the general subject since 1882; the work on Tides will be taken from 1888

only, while Vortex Motion will be omitted altogether.

The application of mathematics to the solution of many natural problems in fluid motion possesses one difficulty which is not common to most of the problems which confront physicists. It arises from the fact that we are frequently unable to apply the method of approximation. It usually happens that when a problem arises from some natural phenomenon it is not capable of direct solution. But the mathematician is generally able to consider a simpler problem which more or less closely corresponds to the given conditions. Having solved it, he is able to take into account the conditions of the actual problem, and so to obtain a solution to any degree of accuracy which may be desired. This is frequently *not* the case with problems in fluid motion. The differential equations of motion may, perhaps, be written down, but the limitations which have to be imposed before a solution can be discovered are so numerous that the solution, when found, often gives no approximation at all to the real circumstances. To illustrate this, we need only mention the case of a sphere moving through water. If we neglect the friction between the water and the surface of the sphere, the viscosity and compressibility of the water, it is easy to find all the circumstances of the motion. But when the velocity of the sphere is not small, and we take these neglected circumstances into account, the motion, as any one will agree, quite changes its character. Instead of the stream lines —that is, the lines followed by the molecules of the fluid—being regular curves, eddies are formed along the surface of the sphere, and the motion in the rear of the sphere becomes turbulent and seems to defy all attempts at calculation. Further, the resistance to motion caused by the fluid, instead of being zero, as in the simplified problem, actually becomes very large. And here, it is to be remembered, we are dealing with a simple case of a class of problems which has a high practical interest—the resistance experienced by a ship moving at a speed which we are accustomed to expect, say, from ten to twenty miles an hour. The engineer now knows fairly well the resistance by experiment. But neither he nor the mathematician can calculate the resistance when the speed is forty miles an hour, and this speed has already become an accomplished fact.

I shall first deal with problems in which the motion is irrotational, that is, where the separate molecules of the fluid are not supposed to possess any rotation of their own independently of the rotation of the whole mass. In a fluid which is non-viscous such a molecular rotation can never be set up by any conservative system of forces. If we neglect the viscosity, and the skin friction of the solid with which it is in contact, all motions considered will be of the irrotational class. This class can be again divided into two others: first, that known as *continuous*, in which the pressure never comes out to be negative; and secondly, that known as *discontinuous*, in which we may have a negative pressure or a surface across which there may be a finite change of velocity. In the first case the fluid completely occupies the spaces around the solid with which it is in contact. In the second case hollows may be formed and there may be a free surface, or the fluid in motion may be in contact with other fluid at rest. After treating these two classes of problems I shall go on to mention the advances made in various kinds of wave motion, including the tides. Then will follow the motions and forms of masses of fluid rotating about an axis under their own gravitation only. Finally, the influence of viscosity will be considered.

We shall first consider those problems in which the fluid is incompressible and with-

out viscosity and its motion is irrotational, steady and takes place in two dimensions. If we take the plane of motion to be that of $(x, y,)$ this class, of course, includes the case of motion in three dimensions where the motion of every particle in a straight line perpendicular to the plane of (x, y) is the same. The theory depends on the velocity-potential φ and the steam-function ψ. If u, v be the velocities of a particle of the fluid at the point (x, y) the following equations hold:

$$u = \frac{\partial \varphi}{\partial x} \quad , \quad v = \frac{\partial \varphi}{\partial y},$$

$$u = -\frac{\partial \psi}{\partial y} \quad , \quad v = +\frac{\partial \psi}{\partial x},$$

$$\frac{\partial^2 \varphi}{\partial x^2} + \frac{\partial^2 \varphi}{\partial y^2} = 0 = \frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2}.$$

Putting $z = x + iy \quad , \quad w = \varphi + i\psi,$

these equations show that the determination of the motion reduces to the discovery of a function

$$w = f(z),$$

which will satisfy the given boundary conditions.

When w has been determined as a function of z, the curves,

$$w = \text{pure imaginary},$$

give the stream-lines, that is, the lines followed by the molecules of the fluid in their motion. The velocities are determined by partial differentiation with respect to x, y.

It is unnecessary to say more about the general problem. It is that of Dirichlet in the Theory of Functions. Solutions can, in general, only be obtained by the inverse process of taking known solutions of

$$\frac{\partial^2 \varphi}{\partial x^2} + \frac{\partial^2 \varphi}{\partial y^2} = 0 \text{ or } \frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} = 0,$$

and inquiring what boundary conditions they can be made to satisfy. When the motion is discontinuous the boundaries, instead of being fixed walls, are free surfaces along which the velocity is constant.

As we are searching for the stream-lines

$$w = \text{pure imaginary},$$

that is, the lines parallel to the real axis in the w-plane, all that is necessary is to find the curves in the z-plane which correspond to lines parallel to the real axis in the w-plane. The problem is, therefore, reduced to one of conform representation. For walls consisting of straight lines a few cases have been long known, being solved by Schwarz's method. Some new ones, with more complicated rectilinear boundaries, were given by Réthy in 1895.

In 1890 Mitchell gave a new form to Schwarz's method which enabled him to solve some further problems in discontinuous motion. These are mainly the cases of jets issuing from apertures into fluid which may be at rest or in motion. This was shortly afterwards modified and extended by Love. Still later B. Hopkinson added the case where several sources or sinks might be present. (These are points where the fluid is supposed to enter or leave in finite quantities.) The transformation does not in general contain infinities, but Hopkinson includes the case where $\frac{dw}{dz}$ becomes infinite like

$$\frac{A_1}{z - z_1} + \cdots + \frac{A_n}{(z - z_1)^n}.$$

Several hydrodynamical examples are given, but the most interesting are the electrical applications.

These problems are of little practical value. They frequently demand the existence of dead water behind the moving solid. For example, if a rectangular board be drawn through a fluid it is directly seen that the fluid behind the obstacle is far from being at rest, which the theory would indicate. Again, if water is entering into

a large tank which is full, by means of a projecting tube in the side of the tank, the fluid, instead of spreading in all directions (by the theory), actually moves like a fluid cylinder for a short distance. In fact, the fluid, instead of moving back along the outside of the projecting tube, actually moves the other way. The difference is, of course, caused by the viscosity of the fluid, which, even when small, produces vortex or eddy motion of a complicated kind. The difficulties have been stated with some detail and with several illustrations by Lord Kelvin in *Nature*, 1894.

Just lately Professor Hele-Shaw has succeeded in photographing the movements of an actual fluid under similar circumstances. It is striking to observe that when the motion of the water takes place between two parallel plates not far apart, and when its velocity is not very great, the stream-lines follow almost exactly the theoretical positions which they would have under the assumptions made above. In the case of a rectangular plate held at an angle of 45° to a steady stream the stream-lines agree almost exactly with the hyperbolas given by theory. When the parallel plates are not close, however, or the motion takes place in a tube of not too small section, any variation in the diameter of the tube soon produces turbulent motion.

When the motion takes place in three dimensions I divide it again into continuous and discontinuous motion. On neither is there much to say. When the motion is continuous, and there are no forces acting on the solid which is moving through the fluid, the system of differential equations admits of three integrals, and the integration is practically finished if we can find a fourth. Several Continental writers have been considering, during the past two or three years, under what circumstances a fourth integral of specified form may exist. Miss Fawcett has examined the case of the motion of a solid of the form known as an isotropic helicoid when gravity is the only force acting. The most interesting case is that where the solid starts from rest. The path followed by the center of gravity is traced. The motion of an anchor ring when there is circulation through the aperture has been discussed by Greenhill, Basset and Dyson. The first-named has applied the σ-functions to the solution of the problem. Basset has also discussed the motion of a spherical bowl. No problem of discontinuous motion in three dimensions has been yet solved, notwithstanding many unpublished attempts. I shall return to this subject later on.

Coming next to the general theory of wave-motion, including the problem of the tides, two main classes may be distinguished. Waves of expansion belong primarily to the theory of sound and they will not be touched upon here. The second class concerns the different kinds of waves which our every-day experience of water in motion brings before us. It includes wave-motion on the large scale as exhibited by the tides, and on a smaller scale in the long waves which are known under the name of a 'ground-swell' in the Atlantic; next the waves whose effects have the greatest destructive power—the short waves whose height is not very small compared with their length—the waves raised by the wind in a river, those which follow in the wake of a ship, the solitary wave travelling up a canal or in some rivers, known in England as a 'bore;' finally, the waves which are very small and which are mainly propagated by the surface tension of the fluid. These last are known as capillary waves and will only be mentioned incidentally. A general distinction of all these waves on the surface of water is made by mathematicians—the long waves, where it appears permissible to neglect the vertical acceleration of the particles of the fluid without materially affect-

ing the results, and the short waves, where this vertical acceleration may not be neglected in the equations of motion. I shall, as far as possible, deal with them in this order.

The neglect of the vertical acceleration, which implies that the dynamical pressure is equal to the statical pressure, greatly simplifies the problem of wave-motion. Neglecting compressibility and viscosity, the ordinary problems of long wave-motion are not very difficult. The motion of long waves in canals is an old problem and was used by Airy for explaining the tides. A paper by McCowan in 1892 on these long waves when the section of the canal is uniform must be mentioned. Usually the canal has been taken to be of rectangular section. McCowan treats one which has sloping sides. Incidentally he obtains a canal of such shape that these long free waves are propagated along it without change of form. But a more important result is the detection of a serious error in Airy's explanation of the double high-tide, sometimes observed in estuaries and rivers. The method adopted was, as usual, one of continued approximation, and Airy fell into the error—not unknown to mathematical physicists—that of carrying his approximations further than the initial assumptions warranted. It appeared that the wave might divide into two or even three waves. McCowan shows that this division of the wave is without foundation when the equations are correctly treated and that, therefore, Airy's explanation of the double high-tide fails. The double high-tide is still unexplained.

The general theory of tides is fully dealt with and brought up to date by Professor Darwin in his article in the Encyclopædia Britannica of date 1888. Two important papers have appeared since then. To report how these two papers have advanced our knowledge of tidal theory, a few remarks must be made on the general problem.

The theory of the tides is mainly one of forced oscillations. The sun and moon, moving in orbits round the earth whose essential nature is periodic, their motions are expressible by means of sums of sines or cosines of angles which vary with the time, and the periods of these terms differ. The difference of the attractions on the earth and the water which covers it produces oscillations with periods which correspond to those of the sun and moon. Hence the periods of the principal tides will be known in advance. Notwithstanding this fact, the general equations which express the motion of the water have hitherto only been integrated on the following assumptions: First, that the particles of water never move far from their mean position in comparison with the radius of the earth—an assumption which is easily justified and need not be discussed. Secondly, that the ocean covers the whole earth supposed spherical. Thirdly, that the depth of the ocean is uniform or a function of the latitude only. Fourthly, that the attraction of the ocean on itself is to be neglected. The last phrase simply means that we neglect the difference of the attraction of the water on itself in its actual form from its attraction in the nearly spherical form it would assume if there were no disturbance.

The irregular shapes of the bed and shores of the ocean make calculation of the effects due to them almost impossible. But the attraction of the ocean on itself should be susceptible to calculation. Hitherto this has always been neglected, owing to mathematical difficulties. Poincaré and Hough, in two papers which have lately been published quite independently and nearly at the same time, have taken it into account. Of these two papers Hough's is the most important in view of the applications.

Previous writers, and particularly Darwin, have used simple sums of harmonic terms. Hough uses Zonal Harmonics and finds that this enables him to include the attraction of the ocean on itself. In particular the fortnightly tide has to be altered from 5 to 8 per cent. owing to this cause. Poincaré makes a rough estimate only, which is double this amount. At the same time he points out that the irregular shape of the continents may alter the coefficients of certain terms to a large extent. In consequence of this he criticises the arguments of Thomson and Tait, who attempt to explain the difference between theory and observation by the solid tides which the moon and sun must produce in a solid earth possessing slight elasticity. He leaves the question open, however. Poincaré's paper contains much more in the way of theoretical researches, which must be omitted here. Hough also determines the free oscillations by means of an indefinite determinant.

When we do not neglect the vertical acceleration of the particles of fluid the mathematical treatment alters and becomes more difficult. It is in general supposed that the height of the wave is small in comparison with the distance between the crests. In 1883 Lord Rayleigh discussed the short waves which are seen in front of an object trailed along the water, and also the longer waves that are left behind. His method is to find the effect produced by a line of disturbance inclined at an angle to the direction of steady motion of the fluid. The effects observed by Froude in his famous experiments on ship-waves are fairly well accounted for. This year a paper by Mitchell has just appeared in which he calculates the wave-resistance due to a body shaped approximately like a ship. Again the results are not unsatisfactory. Lord Kelvin has solved a similar problem in several articles in the *Philosophical Magazine* for 1886–7. He considers the effect of small inequalities in the bed of a stream. Of special interest are the standing waves produced by a stone, or by a hole in the stream-bed, or by a wavy bottom, such as we sometimes see left on the sea shore by the retreating tide.

When the wave-height, wave-length and the depth of the fluid are comparable in magnitude the problem becomes very difficult, as the waves are not in general propagated without change of shape. They were first treated by Stokes. In 1889 von Helmholtz took up the general problem and considered the effect of the wind in making permanent waves. Mitchell has traced the free-wave in the case of infinite depth and its changes as it proceeds. Incidentally he finds again the case where the crest becomes a cusp with an angle of 120°, a result predicted by Stokes from simple considerations. A paper by W. Wien should be mentioned; in it the forms of the waves at the surface of separation of the two media are discussed, and forms for the waves produced by the winds, more or less closely approximating to actual phenomena, are found. The wave-fronts are figured by means of Schwarz's method of representing conformably a lemniscate on a circle.

The solitary wave has received a fair share of attention. In this wave the height is not necessarily small compared with the depth of the fluid, and it may travel for a long distance along a uniform canal with little or no change of form. Experiments have been made and the results published by Scott Russell. Boussinesq and Lord Rayleigh have lately investigated his figures from the mathematical standpoint, and have given a simple formula for the relation between the wave-length and the height which agrees with that deduced by Scott Russell from experiment. Korteweg and de Vries, in 1895, extended the theory of the solitary wave and showed that a new type—named

cnoidal—can be propagated. They also proved that a depression without a corresponding elevation can move along, but such depressions are generally unstable. McCowan and Stokes have also treated these waves. The existence of free oscillations in canals has been investigated by Greenhill, Lamb and MacDonald by Fourier's methods. There is some doubt about Lamb's results. MacDonald has shown that it is necessary to take into account the possibility of satisfying the surface conditions and that simple formulæ are not sufficient; this point will be readily appreciated. The criticism appears to be valid, but the subject needs elucidation.

An interesting problem is obtained by considering the tiny waves formed in a glass of water when the glass is made to vibrate by means of a violin bow drawn across its edge. Rayleigh has shown that they are due to capillary action. It is curious that the number of waves found on the water in a given time is double the number of vibrations made by the glass in the same time.

A good deal of interest has been taken during the last two decades in the forms assumed by masses of fluid rotating about a fixed axis under their own attraction only. Darwin and Poincaré are mainly responsible for the developments which the subject has received, although much has been done by Madame Kowalewsky, Basset, Dyson, Bryan and Love. To give an account of all this work would take me far outside the limits of this paper, and I shall, therefore, simply mention some of the more interesting results obtained by the first two writers.

In 1886 Darwin worked out fully the various possible forms of the Jacobian ellipsoids, showing where the limits of stability came. In 1887 he took up the more general problem of two nearly spherical masses of fluid rotating like rigid bodies round a fixed axis under their own attractions only. This problem is of great importance in theories of cosmogony. Especial attention is paid to the cases where the two bodies get very near to one another. When quite close they may coalesce and form dumb-bell shaped figures. Or the smaller mass may have a tendency to break up into two parts, as shown by a furrowing in its contour.

Poincaré took the subject up from a different point of view. He starts with the rotating ellipsoidal form and investigates what forms of relative equilibrium are possible when small deviations from the ellipsoid occur consistently with the conditions. He figures a pear-shaped form of possible equilibrium, and also discusses, with much detail, the stability of the various figures.

I am indebted to Professor Darwin for a reference to a paper by Schwarzchild, which has just appeared in the Annals of the Munich Observatory. In this memoir certain portions of Poincaré's work, with respect to the exchange of stabilities between two classes of possible figures of equilibrium at the place where they meet, are criticised. He also examines the stability of Roche's Ellipsoids by means of Lamé's functions, and shows that there is no figure of bifurcation in this series.

A considerable amount of attention has been devoted to our last subject, the viscosity of fluids, partly owing to the mathematical interest of the subject and partly to the difficulty of obtaining any close approximation to the results afforded by natural phenomena. It must be stated at the outset that in all the work hitherto attempted the motion is supposed to be sufficiently slow to enable us to neglect the squares and higher powers of the velocities. Practically this entails a serious limitation on the usefulness of the results. Even the most casual observation shows that when

the velocity exceeds a limit which is very easily reached, eddies are formed and the motion entirely changes its character. Korteweg has made some suggestive remarks on this point in a paper on the stability of the motion of viscous fluids. He remarks that the existence and formation of eddies was generally supposed to be due to unstable solutions of the equations of motion. von Helmholtz, however, had found that when a solution with given boundary conditions in a simply-connected region is obtained, that solution is unique. Hence, we cannot attribute the formation of eddies to other solutions which in fact do not exist. Korteweg further proves that this unique solution is stable. Hence, neglecting squares and products of the velocities, it is evident that having got a unique stable solution, eddies cannot be formed. Concerning these eddies, he says: "When, on the contrary, squares and higher powers of the velocities are taken into account I have my reasons for supposing that even in the case of a sphere moving with uniform velocity—if such a state of steady motion can be reached—the motion must finally become unstable." Lord Rayleigh has also attempted to examine how viscosity affects the motion, and how eddies, when formed, are maintained.

"Lord Kelvin concludes that the linear flow of a fluid through a pipe or of a stream over a plane bed is stable for very small disturbances, but that for disturbances of more than a certain amplitude the motion becomes unstable, the limits of stability being smaller the smaller the viscosity." (Lamb's Hydrodynamics.) It is possible that a remark made by Klein in his lectures on the top may have some bearing in this case. He points out that near the limit of stability, obtained as usual by neglecting the second and higher powers of small quantities, instability really takes place when we include them. It is, indeed, possible that all viscous fluid motions as at present investigated are really unstable and that eddies are always formed. It is instructive to read Reynolds' experiments of 1883 as to the point at which, with increasing velocity, stream lines appear to break up into eddies.

A warning must be given against laying too great a stress on the equations of motion. They are formed under certain suppositions as to the character of the internal friction of the fluid, but we have no security that these suppositions represent the facts. At the same time most of the different assumptions made lead to the same equations, so that only a very fundamental alteration would affect the equations of motion.

Another difficulty arises with the skin friction at the surface of a body moving in the fluid. The difficulty arises from the fact that the action along the wall in contact with the fluid is treated quite differently in the cases of no friction and very small friction. The mathematical character of the motion may be completely altered. The difference is this. With non-viscous fluids we assume a finite slip of the fluid along the wall. If even the smallest coefficient of friction be introduced, a finite slip cannot be consistently allowed. The whole subject is very obscure. It is now believed by some prominent physicists that no such finite slip actually takes place at all.

A somewhat easier problem is the decay of waves proceeding along water, owing to the influence of viscosity. In several short papers during the last three years in the *Comptes Rendus*, Boussinesq has treated the various kinds of waves, in many cases reducing his results to numbers. A practical application is a determination of the time necessary for the sea raised by a storm to subside. Hough has treated a similar problem, namely, the effects of viscosity on ocean currents and on tides of long period.

He concludes that for big slow currents—such as the Gulf Stream—the friction of the ocean bed is by far the most important factor in the dissipation of the energy of motion, while for the short waves in deep water viscosity becomes paramount. The continued existence of ocean currents is a problem not satisfactorily explained. They are usually attributed principally to the tendency of the winds to blow on the average mainly in one direction. Against this is urged the dissipation of the energy thus acquired, by the viscosity of the fluid. Hough concludes that too much effect has been attributed to viscosity. Such currents will doubtless take a long time to start, but when once set in motion the modulus of decay is so large that energy is dissipated very slowly and the winds are sufficient to supply the energy lost by viscosity. The long-period tides, again, are supposed to be greatly affected by viscosity. If, however, Hough's conclusion that the modulus of decay is comparable more nearly with 20 years than with a few months those tides whose periods are as great as one or even six months will be but little affected. Hence the differences between observation and the results of the equilibrium theory of the tides, originally attributed to viscosity, cannot be explained in this way.

A few special problems of motions of solids have been solved, the squares of the velocities being neglected. The motion of a sphere and the linear motion of an ellipsoid in an infinite fluid had been solved. Edwardes, in 1892, added the rotational motion of an ellipsoid and the motion of fluid through a channel bounded by a hyperboloid of revolution. As before stated, the results have little more than a mathematical interest.

To attempt to give any idea of the possible directions in which future progress is likely to be made is a dangerous task. One can, however, do something by mentioning the problems in which a little progress has been made and also those which have been before the scientific world for some time and remain yet unsolved. For some of the indications given below I am indebted to friends who have themselves contributed to recent progress.

Problems in discontinuous motion in two dimensions in an infinite, frictionless, incompressible fluid are now without fundamental difficulties. In fact, they are mainly exercises in conform representation. The problem is reduced to that of finding a function to satisfy Laplace's equation for two dimensions with given boundary conditions. No special service will be gained by hydrodynamics, by solving for new forms of boundaries, unless the cases arise in experiment. But I have mentioned the fact that no problem of discontinuous motion in three dimensions has yet been solved. The difficulty is one which can easily be appreciated. The theory of functions deals with a complex of the form $x + iy$, and this suits all problems in two dimensions. But little has been done with a vector in three dimensions, and certainly nothing has been built up concerning it which corresponds to the results obtained for the two dimensional-vector. The subject of discontinuous motion was set for the Adams prize in 1895; this is the prize which has produced Maxwell's essay on Saturn's Rings and J. J. Thomson's on Vortex Motion. A solution for a solid of revolution was asked for, and it was generally supposed that the circular disc would be the easiest to attempt. No essay was sent in. One prominent mathematician, who has aided considerably in the development of hydrodynamics, mentioned that he had worked for six months and had obtained absolutely nothing. A magnificent reception, therefore, awaits the first solution!

Some mention has been already made of difficulties awaiting solution in tide and

wave problems. Whether much more can be done by the present analytical methods is not certain. We may frequently meet in this department with series which formally satisfy the equations, but which either converge very slowly or not at all. The theory of free and forced waves, depending to a large extent upon methods of approximation, when numerical results are required for comparison with observation, is in many respects fairly satisfactory if the height of the wave crest above the mean level is not very great and if the motion is slow. But there are comparatively few problems solved for shorter waves in confined bodies of water. The oscillations of water across a canal of circular section is an instance of a problem which should yield to analysis. But little is known of the causes which produce double and other curious kinds of tides in enclosed areas.

Another class of problem is the wave-resistance experienced by various shaped bodies moving over water, especially when the velocity is not small. That this class is becoming extremely important, in view of the high speeds attained by torpedo boats, there can be no doubt. The lines of a ship are at present a matter mainly of experience. One of the most puzzling things is the difference in the speed qualities of two ships built on the same plans. A very slight difference in the lines will frequently enormously alter the speed qualities, and one can scarcely doubt that this is due to the differences in the waves which are formed as the ship moves. The kind of problem thus presented to the mathematician is always a difficult one. Briefly stated, it is a problem where a slight difference in the boundary conditions makes a large difference in the effects produced. A similar difficulty occurs when one approaches the limits of stability of steady motion.

The treatment of viscosity and skin friction seems to be a subject lying nearer to one's grasp. The difference between no viscosity and small viscosity—namely, the mathematical assumptions of finite slip—and no finite slip—has already been pointed out; this requires further investigation. Again, the fact that in all problems hitherto solved, only the first powers of the velocities are taken into consideration seems to point to an opening for research. We cannot hope that, even should this single difficulty be overcome to a certain extent, the mechanical difficulties would be made much easier. But every step taken ought to lead to some further insight into the most intractable subject that mathematical physics presents. It must be admitted that the practical engineer has almost no use for any of the results obtained by the theory as it at present stands. It may be answered that pure science does not look to practical ends. This is perfectly true in general. But it can hardly be an argument in the case of hydrodynamics, the very bases of which are assumptions which are supposed to approximate more or less closely to actual conditions.

In conclusion, I cannot resist making, or rather repeating, an appeal to our pure mathematicians to devote more attention to this subject. The literature is easily accessible. The English treatises of Lamb, Basset, Thomson and Tait will supply most of the needs of a student, while the works of Voight and Kirchhoff and the Handbuch der Physik of Winkelmann may be used to supplement them. Again, Stokes' report of 1846 and that of Hicks in 1881–2 will furnish the main points in the history of the subject. On Vortex Motion we have the later paper of Love in 1887 and the presidential address of Hicks to the British Association in 1896. On Tides, Darwin's article in the Encyclopædia Britannica brings our knowledge up to 1888. Most of the work done since 1882

is to be found in the columns of such easily accessible periodicals as the Philosophical Magazine, the Proceedings of the London Mathematical Society and the Proceedings and Transactions of the Royal Society. A full index of titles of papers up to date, with short abstracts, is obtainable from the Jahrbuch über die Fortschritte der Mathematik and the *Revue Semestrielle*.

It is, of course, unfair to ask anyone successfully engaged on his or her own special line of research to leave it for doubtful profit in another. But much may be done by those who have the direction of the studies of the future generation by interesting and suggestive courses of lectures. Pure mathematicians will not find their knowledge useless here, and students will not be backward in following the footsteps of such men as Laplace, Stokes, Kelvin, von Helmholtz and Rayleigh. The tendency towards the separation of pure mathematics from their applications to physical problems has already been arrested. The future progress of Hydrodynamics appears to demand a closer union of these two branches of science.

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BOTANY AT THE ANNIVERSARY MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

I.

SECTION G was organized Monday noon, August 22d; Dr. W. G. Farlow, President. Regular sessions were held Tuesday morning, afternoon and evening and Thursday morning and afternoon; Wednesday and Friday being given up to excursions. Fifty-six papers were listed and forty-seven were read.

Thursday morning Mr. A. B. Seymour, on behalf of the Committee on Bibliography, appointed at the Madison meeting, made a report of progress, which dealt principally with the question of subject arrangement. On motion of the Secretary, the Section directed the Committee to include Bacteriology in the list of subjects covered by this Bibliography.

The large number of papers and the limited time prevented full discussion in many instances. Numerous excursions also interfered more or less with the regular work of the Section, but these afforded much pleasure to all who could take part in them and were not least of the Boston attractions.

Visiting botanists were very hospitably entertained, and altogether the Boston meeting was exceedingly pleasant and profitable.

The following abstracts have been prepared with much care, in most cases from the authors' MSS. or abstracts, and it is to be hoped that they are reasonably free from errors, and ample enough to give the many who could not be present a clear idea of what was said and done.

The Carposporic Type of Reproduction of the Rhodophyceæ. BRADLEY M. DAVIS.

RECENT investigations in this field of research show a tendency to depart from the teachings of Fr. Schmitz. These were characterized by the assumption of a second act of fertilization in the Rhodophyceæ exhibited in the phenomenon of fusion between auxilliary cells and filaments or processes put out by the carpogonium. The speaker described studies of his own upon *Champia*, showing their divergence from the doctrines of Schmitz, and followed with a more general discussion of the peculiar conditions found here, expressing himself as in sympathy, in the main, with the recently published views of Oltmann. All evidence at present points to the probability that the cell-fusion phenomenon following the development of the carpogonium is associated with and the result of nutritive functions. The entire group of Rhodophyceæ is so pe-

culiar that any attempt to establish a general type of reproduction is fraught with great danger.

The Comparative Morphology of the Pistils of the Ranunculaceæ, Alismaceæ and Rosaceæ. Ernst A. Bessey.

The uni-ovulate pistil in the Ranunculaceæ originates as an open leaf in whose axil grows a mass of cells from the receptacle forming one side of the cavity of the pistil whose other sides are formed by the laminæ and by the curved distal portion of the carpel. Into this cavity grows a median ovule from the axillary mass of receptacular cells. *Sagittaria* and *Alisma* have practically the same structure, except that the ovule in the latter grows directly from the receptacle instead of from an outgrowth of it. *Potentilla* and *Fragaria* show a course of development very similar to the foregoing; an open pistil is formed, but the ovule, instead of growing from the receptacle, grows from the thickened edge of one or the other of the laminæ. This similarity of development apparently supports that system of classification of the Angiosperms, in which there are three diverging lines of development having a common origin, one with the Alismaceæ first, being the Monocotyledonæ, the two others forming the Dicotyledoneæ, one with the Ranunculaceæ lowest being the Thalamifloræ and passing up to the Heteromeræ and to the Bicarpellatæ, the other with the Rosaceæ lowest being the Calycifloræ and passing up to the Inferæ.

Origin and Homologies of Blepharoplasts. Herbert J. Webber.

The new features emphasized by the author in this paper were as follows: The blepharoplasts in *Zamia* arise *de novo* in the cytoplasm of the generative cell, as previously described by him in the case of *Ginkgo*. They appear first as minute bodies with a few kinoplasmic filaments centered upon them. At this time no differentiation into outer membrane and interior contents can be distinguished. As they increase in size the radiating filaments become more abundant and an outer membrane becomes plainly differentiated.

In the bursting of the blepharoplast to form the spiral cilia-bearing band of the spermatozoid the first change, other than increase in size, is distinguishable in an early prophase of the division of the generative cell. The vacuolated contents of the blepharoplast begin gradually to contract away from the outer membrane, which meanwhile increases in size. When the division has reached the metaphase the contents have become contracted to a very small body, and the outer membrane, which has become considerably extended, is shown in section to be broken into numerous segments or plates. The disappearance of the central nucleolus-like contents seems to be correlated in some way with the growth of the outer membrane. Appearances suggest that it is utilized as food matter in the growth of the membrane. In the next stage which the writer has studied, an early telephase, the blepharoplast is represented by numerous round or oblong granules grouped in a somewhat irregular spherical mass, which stain the same as the outer membrane of the blepharoplast in the preceding stage. It would seem that the outer membrane of the blepharoplast breaks up into numerous segments which assume a roundish form and become crowded together into a spherical mass through the action of the cytoplasm.

In a late telephase a slender membrane can be discovered protruding from this mass of granules and bending toward the nucleus. As the development advances, the membrane grows in length and width, and the granules meanwhile gradually arrange themselves along one side and decrease in number. During the further development

of the membrane the granules gradually disappear and apparently either unite directly to form the membrane or are absorbed through its growth. Some preparations give evidence that the granules fuse together to form the membrane, and the writer is inclined to this interpretation of the phenomena presented.

The further stages in the elongation of the membrane into the cilia-bearing band of the antherozoid have been described by the writer in another place.

The Blepharoplast in the Spermatogenesis of Marsilia. DR. W. R. SHAW.

IN the development of the male prothallia of *Marsilia vestita* no blepharoplasts or other centrosome-like bodies are found in any of the six cell divisions or resting stages preceding the formation of the primordial spermatogenous cell, 'central cell,' of each of the two antheridia; nor are any such bodies found in that cell or during its division. The first appearance of centrosome-like bodies is in the spindle poles during the telephase of the second division of the spermatogenous tissue. After this division is complete, *i. e.*, in the 'grandmother cells' of the spermatids, each of these bodies grows into a pair of *blepharoplastoids* which increase in size. They remain together and move into the other region of the cytoplasm, and disappear during the following cell division. During the anaphase or telephase of this division there are formed, at the poles of the spindle, new bodies. After the division, *i. e.*, in the 'mother cells' of the spermatids, each of these bodies develops into a pair of *blepharoplasts*. The blepharoplasts separate, at the same time increasing in size, and move to opposite poles of the cell, where they remain throughout the last division leading to the formation of the spermatids. The further development closely resembles that of the blepharoplasts in the spermatozoids of the cycads.

Observations on the Relative Moisture Content of Fruit Trees in Winter and in Summer. PROFESSOR C. S. CRANDALL.

FROM samples of trunks and branches of apple trees taken January 15th and 16th and August 3d, and thoroughly air-dried, with careful weighing before and after, the author concludes that, as grown under Colorado conditions at least, there is hardly an appreciable difference between the summer and winter moisture.

In the discussion which followed, Professor D. T. MacDougal stated that the water content in the trees in August was practically the winter content, the separative layer in the leaves having probably already begun to form, and that for the determination of the *summer moisture* samples should have been taken sixty to seventy days earlier.

Some Observations bearing upon the Symbiotic Mycoplasm Theory of Grain Rust. PROFESSOR H. L. BOLLEY.

MANY facts and arguments go to show that Erickson's hypothesis has not been established, and is not necessary to account for the first appearances of grain rust. The author finds that uredo and æcidiospores (*Aec. berberidis*, *U. rubigo-vera* and *U. graminis*) germinate readily when placed under favorable conditions; that, when other conditions are the same, shaded, spindling plants are as much subject to infection as those grown in the sunshine, and, finally, that when oats and wheat were grown in rust-proof cages there were no infections whatever, although close outside and for miles around every plant bore numerous pustules.

Some Unique Examples of Dispersion of Seeds and Fruits. PROFESSOR W. J. BEAL.

A POPULAR account, illustrated by specimens. To be printed in full in *The American Naturalist.*

Starch Distribution as affected by fungi. DR. BYRON D. HALSTED.

The leaves to be studied are placed in 50 per cent. alcohol to remove the chlorophyll, and are then passed into a weak solution of iodine. In a few hours, if the leaf is thin, the starch responds to the iodine test and is located by the blue color it assumes. Tested in this way the parts of plants which are attacked by fungi, *e. g.*, leaf spots due to Peronospora, Cystopus, Synchytrium and Puccinia, and galls due to Cystopus, Gymnosporangium, Plasmodiophora and Rhizobium show a marked accumulation of starch. The starch is either in the discolored spot or immediately around it. This distribution is very striking in the leaves of Podophyllum attacked by *Puccinia podophylli*, starch being abundant in the well-defined areas, while none was met with beyond the small veins that served as boundaries to the infested portions. The galls of peach roots, the cause of which is still unknown, are gorged with starch. Turnips affected by club root carry a large amount of starch, while the healthy tissue is comparatively free from it. In like manner, the root tubercles of the Leguminosæ contain much starch, while the roots which bear them are comparatively free from it.

The Effect of an Atmosphere of Ether upon Seeds and Spores. Dr. C. O. Townsend.

In order to determine the effect of ether upon the germination of seeds and spores a series of air-tight damp-chambers holding one litre were prepared. After soaking the seeds for twenty-four hours in pure water they were transferred to the damp-chambers which contained respectively 1, $2\frac{1}{2}$, 5 and 10 cc. of ether dissolved in 100 cc. of water. One chamber was left free from ether for comparison. It was found that 1 cc. of ether hastened the process of germination slightly, but the subsequent growth of the seedlings was somewhat retarded by the action of the ether. In the chambers containing $2\frac{1}{2}$ and 5 cc. of ether the process of germination was retarded. The amount of retardation varied from a few hours to several days, depending upon the strength of the ether atmosphere and upon the kind of seed used. An atmosphere containing 10 cc. of ether prevented the seeds from germinating. If the seeds were removed from this strong atmosphere of ether at the end of from seven to ten days, and placed under favorable conditions, they germinated as readily as if they had not been placed in the ether atmosphere. On the other hand, if the seeds remained in the strong atmosphere of ether two weeks they seemed to lose their vitality.

The influence of an ether atmosphere upon spores was investigated by placing the spores upon plates of gelatine containing 10 cc. of sugar. These plates were then placed in damp-chambers containing $\frac{1}{10}$, $2\frac{1}{2}$, 5 and 10 cc. of ether, one chamber remaining free from ether for control, the spores in the atmosphere containing $\frac{1}{10}$ cc. of ether germinated a little earlier than did those in the ether-free atmosphere, while those in the stronger atmospheres of ether were retarded in germinating. Not only did the spores continue to live in the atmosphere containing 10 cc. of ether, but they were able to germinate in about ten days without removing from the ether atmosphere. The amount of retardation was found to depend upon the strength of the ether atmosphere and upon the kind of spores.

The Toxic Action of a certain Group of Substances. Dr. Rodney H. True.

Zoologists and botanists have long regarded certain salts, of which sodium chloride and potassium nitrate are commonly-used representatives, as being essentially lacking in toxic action and operative only through their osmotic activity. In this study cane sugar was assumed to be a purely osmotic agent, and the concentration

in which the majority of a number of filaments of Spirogyra survived, after an exposure of twenty-four hours, was regarded as the measure of the osmotic action which the alga can endure. This boundary concentration was found to lie at 0.75 gram molecules per litre. Assuming the action of the other substances studied, viz.: glycerine, potassium nitrate and sodium chloride, to be likewise purely osmotic, the boundary concentrations were calculated to lie as follows: glycerine, 0.75 gram molecules per litre; potassium nitrate, 0.45 gram molecules; and sodium chloride, 0.47 gram molecules. The actual boundary concentrations found by the method used for sugar were as follows: glycerine, $\frac{1}{2}$ gram molecules per litre; potassium nitrate, $\frac{1}{16}$ gram molecules; and sodium chloride, $\frac{1}{10}$ gram molecules. The concentrations producing plasmolysis were as follows; glycerine, $\frac{1}{3}$ gram molecules per litre; potassium nitrate, $\frac{1}{4}$ gram molecules; sodium chloride, $\frac{1}{4}$ gram molecules; and sugar, $\frac{1}{3}$ gram molecules. The boundary concentration for glycerine lies at a concentration greater than that of the cell sap, and probably causes death by osmotic action. The boundary concentrations of potassium nitrate and sodium chloride lie much below the point having the same osmotic value as the cell sap, and much below the boundary concentration calculated on the assumption of purely osmotic action. Consequently, potassium nitrate and sodium chloride exert a pronounced toxic influence upon Spirogyra.

Types of Vegetation on the Florida Keys. C. L. POLLARD.

PAPER, partly ecological, partly floristic. Six distinct belts or zones of plant life are recognized. The main part of the paper consisted of an enumeration and discussion of the characteristic species of these belts, as observed during a six weeks' visit in the spring of 1898.

Potato as a Culture Medium with some Notes on a Synthesized Substitute. DR. ERWIN F. SMITH.

THE length of this report makes it seem best to relegate the abstracts of my own papers, which are long and rather technical, to the forthcoming volume of the Proceedings of the Association, where they may be found by those who desire to consult them.

Some Little Used Culture Media, which have proved valuable for Differentiation of Species. DR. ERWIN F. SMITH.

The Temperature and Transpiration of Desert Plants. PROFESSOR D. T. MACDOUGAL.

THE author reported data taken from field notes made in the desert of the Little Colorado River in 1898.

The temperatures of the bodies of succulent plants in this region at midday is often as high as 45° C., the critical point of protoplasm, and 6° to 8° higher than the surrounding air. The enormous transpiring force exerted is met by the high-soil temperature, which in volcanic sand reaches 40° to 42° C. around the absorbing roots. The actual amount of water used by desert plants, when furnished with an unlimited supply, is very small, however. By use of a potometer it was found to be not more than one-tenth as much as from a corresponding mesophyte of temperate latitudes. Desert plants are, therefore, incapable of great transpiratory or absorptive activity.

The Leaf-spot Disease of the Apple, Phyllosticta pirina, and Several Unrelated Forms occurring therewith. PROFESSOR WM. B. ALWOOD.

PAPER records common occurrence and life cycle of *Phyll. pirina* Sacc. and the occurrence therewith of three apparently unrelated forms, viz.: *Sphæropsis malorum*, *Hendersonia mali*, and an undetermined species.

Notes on Some Diseases of Southern Pines. HERMANN VON SCHRENK.

OF the numerous fungous parasites of the southern pines *Trametes pini* is one of the most destructive. It attacks older trees, entering through a knot and causing decay of the heartwood up and down the trunk. The mycelium dissolves portions of the wood fibers, at first changing them to cellulose. After a time the solution stops, and the wood then appears full of holes with a white lining, the holes separated by lamellæ of apparently sound wood. The 'local' action of the mycelium is characteristic of numerous fungi destroying wood. The wood not destroyed seems to be protected against the attacks of the fungus ferment by some substance which infiltrates into the wood cells. In the wood attacked by the mycelium of *Trametes pini*, a compound allied to the humus compounds was found, giving the wood a brown color. It is possible that this may be one of a class of preventive substances.

Another prevalent disease is due to *Trametes radiciperda*, which enter the trees through the roots. The mycelium passes up the trunk, causing decay similar to that of *Trametes pini*. It was found destroying numerous trees of *Pinus palustris* and *P. echinata*.

A remarkable Increase in Size of Leaves of Kalmia angustifolia apparently due to Reduction of Light. PROFESSOR W. J. BEAL.

ON May 14, 1898, before flowering, some plants with a little soil attached were removed from an open place at Grayling, Michigan, where they are common, and transferred to the State Agricultural College, 130 miles south, where they were planted in muck, kept wet, and screened about 8 feet from the ground with laths and the leaves of trees, which cut off at least one-half of the light during the middle of the day and a larger per cent. morning and evening. On July 28th the three branches here exhibited were cut from the plants and pressed till dry. The largest leaf on each branch (measured when dry) is 37×17, 45×16 and 47×15 millimeters, while the largest evergreen leaf (growth of the previous year) is 22×9, 25×6 and 25×6 millimeters, *i. e.*, a leaf of this year easily has a surface four times that of a leaf of last year. Similar results were obtained with *Kalmia glauca*. No control plants were retained.

Half Shade and Vegetation. DR. BYRON D. HALSTED.

EXPERIMENTS were made in shading various truck crops with frames of lath placed upon supporting stakes. The space between the lath equalled the width of the lath, so that one-half of the direct rays were intercepted. The temperature under the frames (monthly averages of daily observations) was lower than in the full sun, as follows: May, 4°; June, 4.2°; July, 6.5°; August, 7.7°; September, 16.6°. In general the shade retarded germination, noticeably of the first crop of lima beans, but the opposite was true for the second, or mid-summer planting. All root crops, such as turnips, carrots, potatoes, had a larger leaf surface in the shade, but the roots were smaller. Shade improved the salad crops, lettuce, spinach and Swiss chard. The crop most improved of all by shade was celery. With seed, or fruit-producing crops, such as beans, peas, egg-plants, tomatoes, cucumbers, the time of blooming was retarded and the period of fruitfulness materially prolonged. The foliage is of a deeper green in the shade than in the open. In carrots there is a strong tendency to broaden the dissected portions; in short, in the various crop plants there is an attempt to increase the size of the blade of the leaf. The behavior of the plants was also dissimilar. For example, the exposed bean plants in

the brightest and warmest days made all sorts of shifts to reduce the exposure, changing the position of the leaflets from morning until evening, while in the shade the leaflets hung out horizontally and were not noticeably heliotropic. The leaves in the shade were usually much thinner than those grown in full exposure. The record of this fact was made by sunprints of the leaves themselves, the shaded ones invariably being less opaque than the ones grown in the sun. Numerous sunprints were shown to establish the fact of the lesser density of the shade-grown leaves. A study of wild plants along the same lines was made in a wood lot and adjoining clearing. The cinnamon fern (*Osmunda*) was noted in particular to have graceful, drooping leaves in the wooded land, while in the open the fronds were nearly upright. The leaflets of this fern grown in the shade were .098 millimeters in thickness, while in the cleared land the thickness was .258 millimeters. Many other differences as to hairiness, color of stems, etc., were noted.

Influence of Wet Weather upon Parasitic Fungi.

DR. BYRON D. HALSTED.

THIS paper records a striking parallelism between excessive rainfall and the abundance of fungi. May of the present year was remarkably wet, and the following June brought an abundance of parasitic fungi, rust of hollyhock, cedar and mandrake; smut of spring lily, wheat and oats; and many other. The peach-leaf curl fungus was common everywhere. The year 1889 was noted for its wet summer and also for the destruction of potatoes by the rot. The year, since then, nearest like 1889 was 1897, when again July was phenomenal for heavy precipitation, it being 10.19 inches in 1889 and 11.42 in 1897. Last season was like that of 1889 in the outbreak of the *Phytophthora* in the potato fields, causing the wholesale rotting of the tubers. The *Phytophthora phaseoli* Thaxter was discovered in 1889 and reappeared destructively last season. The records of the New Jersey Experiment Station show that in both of the years mentioned there was much black rot (*Physalospora Bidwellii* Ell.) of the grapes and rust (*Gymnosporangium macropus* Lk.) in the apple orchards. In 1894 the growing season opened with a wet May and closed with a rainy September. There were long periods of cloudy weather, and often it was hot and showery. It was this year that witnessed the unprecedented outbreak of the fire blight of apple, quince and pear.

In 1896 there was a rainy June and July, and during this period the asparagus rust (*Puccinia asparagi* DC.) made its appearance in the eastern United States to an alarming extent, and last year it was in even greater abundance. There are not sufficient data for safe and substantial generalizations, but heavy rainfalls in spring seem to induce rusts in grains and orchard and garden crops, and the fire blights of fruit trees. Mid-summer precipitations favor the decay of fruits, particularly the stone fruits, and the rotting of potatoes. Rainfall does not express all the meteorological conditions that need to be taken into consideration in this connection.

In the discussion Dr. Smith noted that peach-leaf curl, *Taphrina deformans*, was reported to the United States Department of Agriculture in the spring of 1898 from a great many places throughout the country, causing more complaint than at any time during the previous 12 years.

The Botanic Gardens of Buitenzorg, Java.

DAVID G. FAIRCHILD.

THIS was a popular lecture, illustrated by about forty lantern slides. The speaker announced that one of the main objects of the lecture was to interest Americans in the establisment of a stipendium of $1,000 by means of which an American botanist

or zoologist could visit the gardens every year and spend from six to eight months in study there. Slides were exhibited showing the remarkable extent of the gardens, their adaptability to the cultivation of any tropical plant, their especially rich collection of palms, Pandanus and ficus trees, their many new and well equipped laboratories, the herbarium and library. Photographs of the native gardeners and collectors, which form such an important part of the gardens, were also exhibited. The attempt was made to give an idea of the wealth of biological, both botanical and zoological, material which was to be found there, and stress was laid upon the importance of laboratory facilities in the tropics. The beauties and charms of Dr. Treub's mountain garden at Tjibodas were illustrated, and botanists and zoologists were exhorted to make the effort to see this unparalleled hermitage of tropical biology. The remarkable growth of the gardens in recent years, and the attention and stipendia which Dr. Treub has attracted to it, made it seem probable in the speaker's mind that Buitenzorg will be soon the International Biological Institute of the Tropics, as Naples is the International Marine Biological Institute.

Notes on the Strand Flora of Florida. Herbert J. Webber.

This was a popular lecture illustrated by fifty lantern slides. The east coast of Florida as far south as Biscayne Key (latitude about 26° 75′) is lined with low sand dunes ranging from ten to thirty feet in height. The coast line is being gradually extended by the deposition of sand, which is probably carried southward from the Cape Hatteras region. In almost every peninsula and island along the coast of this portion of the State numerous ridges or series of ridges several hundred feet apart, evidently lines of old dunes, run parallel with the coast and mark various stages in its recession. The deposition of sand carried by the waves forms shoals or banks 200 to 400 feet from the shore. This gradual piling-up under the action of currents and waves evidently goes on until the bank becomes sufficiently high to protrude from the water at low tide, and then the wind and waves throw it up still higher. Where these banks remain above water for several months certain dune-building plants, such as *Sesuvium portulacastrum*, *Iva imbricata*, *Cakile maritima*, *Panicum amarum*, etc., spring up, and as they grow the wind banks the sand around them, thus forming a low lines of dunes, to which the sand washed up by the waves is being continually added.

The formation of new lines of dunes in front of the old ones, now lining the shore, plainly shows the gradual recession of the coast line. The dunes now lining the coast at Daytona consist of two parallel ridges of equal height, close together (50 to 100 feet apart), and in some places of a third line in various stages of formation. After the dunes reach the usual height vegetation covers their surface, and thereafter the wind has little effect on them, except gradually to increase their width and height.

Uniola paniculata is the main sand-binding grass to be found on the top and seaward side of the first line of dunes. Here it forms almost 75 per cent. of the vegetation, and this zone may, therefore, be properly termed the *Uniola* formation. Species of *Spartina*, *Panicum*, *Ipomœa*, *Yucca*, *Serenoa*, *Croton*, *Euphorbia*, *Opuntia*, etc., are also commonly found mingled with *Uniola*, but only to a small extent. At the base of the main line of dunes a number of plants grow naturally and serve as dune builders. The principal ones of these are *Pancium amarum*, *Ipomœa pes-caprœ*, *Batatas littoralis*, *Iva imbricata*, *Cakile maritima*, etc. These are also found to a greater or less extent on

the tops of the main dunes and in salt marshes, but play their most important rôle in dune building. Growing in bunches, as they do, they catch and hold the sand which is continually drifting about at the base of the dune, and in the course of time banks of increasing height are formed about them until a second line of dunes, nearer the water, is formed.

The islands and keys along the mainland from Biscayne Bay to Key West are of coral formation. Here the vegetation, which is mostly tropical, differs totally from that of the sand dunes above described; the 'mangrove formation,' so well described by Schimper and Karsten, being the most common. Probably the most interesting strand plant of the open beaches in this section is *Agave decipiens*, which is widely distributed along the strand of tropical Florida, being disseminated almost wholly by bulblets produced in place of the flowers. These bulblets are not injured by extended soaking in salt water. They are usually carried here and there by the tide, are thrown up on the beach by the waves, take root, and produce new plants.

The islands along the west coast of Florida are largely of mangrove formation. Shoals are formed by the action of the water, and on these the mangrove finally takes root, and the roots catch and retain sea weeds and other floating matter, thus gradually building up a humus earth around the trees. On the seaward side these trees interrupt the waves, and thus in time a bank of shell is thrown up, and where the forces continue for long periods more or less extended islands are formed. In their simplest form these consist of a low ridge along the seaward shore, composed mainly of fragments of shell thrown up by the waves, and a mangrove swamp on the landward side. In time the interior of the forming island becomes too high for mangrove vegetation, and the latter gradually gives place to the typical hammock vegetation, that is, live oak, palmetto, etc., which in Florida usually covers all soils rich in humus. The typical islands along this section of the coast, therefore, are composed of a central tract of hammock bordered on the seaward side by a belt of sterile shell land from 100 to 600 feet wide and on the landward side by a mangrove swamp.

The most characteristic plants of the mangrove formation are *Rhizophora mangle*, *Avicennia nitida*, *Laguncularia racemosa*, etc. The most characteristic of the shell belt on the seaward side are probably *Forestiera porulosa*, *Myrsine rapanea*, *Coccoloba uvifera*, *Juniperus virginiana*, etc. Here, as on the east coast, *Iva imbricata*, *Cakile maritima*, *Ipomœa pes-caprœ*, etc., grow abundantly on the margin of the water.

Notes on the relative infrequency of Fungi upon the Trans-Missouri Plains and the adjacent foothills of the Rocky Mountains. PROFESSOR C. E. BESSEY. (Read by title.)

Fungus gardening as practiced by the Termites in West Africa and Java. DAVID G. FAIRCHILD and O. F. COOK.

IN the absence of Mr. O. F. Cook the matter relating to Javanese Termites alone was given. Mr. Fairchild called attention to the presence of three species of Termites as yet unidentified which are fungus growers. The nests of these insects are composed of two parts: (1) the earthen-walled galleries, consisting of tunnels in every direction through the earth or even above it, made by cementing together mouthfuls of mud which the workers of these colony-producing insects deposit like brick layers on a wall; and (2) the wooden maché combs which form the gardens of the Termites, which are built up of wood particles that have passed through the bodies of the workers. These combs are miniature labyrinths, the walls of the passages being covered, top, bottom and sides,

with a microscopic sward of fungal hyphæ, which give to it the appearance of a neatly-cut lawn. Rising scattered over this lawn are innumerable cabbage-shaped bodies from microscopic beginnings up to sizes as large as that of a pin head. These bright, almost pearly lustrous bodies, which give to the galleries a most fairy-like appearance, are the compound conidiophores of a species of fungus, presumably a hymenomycete, although cultures of the spores of the mature hymenomycete found growing from the combs failed to establish a connection between the mature form and the cabbages, or more properly termed *cauliflowers*, since they, like the cauliflower, contain organs of propagation.

Photographs showing the nests of three distinct species of Termite possessing three distinct forms of cauliflowers were shown, and attention was called to the fact that these three species of Termite, although building their nests side by side, often in contact with each other, begin immediately a deadly warfare with each other whenever the workers or soldiers, which latter possess large shear-like mandibles, of one nest trespass upon the domains of a neighbor. Unlike the wars of the real ants, in which, as Lubbock has shown, each nest is a unit and its inhabitants war with the inhabitants of any other nest of the same species, the wars of the Termites are race or species affairs. Termites of one species collected in Buitenzorg, Java, and taken to Tjibodas, some 15 or more miles distant, showed the friendliest relations with individuals of the same species collected there, while individuals of different species, though coming from nests actually almost touching each other in the same hill, fought in the arena of an inverted watch glass, invariably, until one or the other was killed, and often mutilated in a most shocking manner. The fights of these Termites offer unrivalled opportunities for a study of the psychology of these lower animals. The fact that these Termites do actually live upon the 'cauliflowers' of the fungi found growing in their nests was proved by repeated examinations of their stomachs, in which the remains of characteristic conidiophores and half-digested conidia were discovered. The extreme sensitiveness of the insects to light prevented direct observations being made as to their method of eating the cauliflowers.

The three forms of conidiophores were remarkably distinct mycologically, and yet the general effect of the cauliflowers made up of these conidiophores grouped together in masses was much the same. Drawings illustrative of these differences were shown.

Erwin F. Smith,
Washington, D. C. *Secretary.*

(*To be concluded.*)

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*ACTA OF THE INTERNATIONAL CONFERENCE ON SCIENTIFIC LITERATURE.**

OPENING MEETING, TUESDAY, OCTOBER 11

1. Professor Darboux moved that Sir John E. Gorst be the President of the Conference. The vote having been unanimously accepted—

2. Sir John Gorst took the chair and welcomed the delegates. It was then resolved:

3. That Professor Armstrong be the Secretary for the English language.

That Professor Korteweg be the Secretary for the German language.

That M. La Fontaine be the Secretary for the French language.

4. That the Secretaries, with the help of shorthand reporters, be responsible for the *procès verbal* of the proceedings of the Conference in their respective languages.

5. Professor Foster read out the names of delegates appointed to attend the Con-

* From *Nature*; a copy has not as yet been received by Science.

ference, and gave an account of the correspondence relating to the non-representation of certain countries.

The following resolutions were then agreed to:

6. That the ordinary hours of meeting be 11 a. m., to 1 p. m., and 2:30 to 4:30 p. m.

7. That each delegate shall have a vote in deciding all questions brought before the Conference.

8. That English, French and German be the official languages of the Conference, but that it shall be open for any delegate to address the Conference in any other language, provided that he supplies for the *procès verbal* of the Conference a written translation of his remarks into one or other of the official languages.

9. Professor Foster having formally presented the Report of the Committee of the Royal Society, copies of which were forwarded, in April last, to the several governments represented at the Conference, the discussion of the recommendations was opened, and it was resolved:

10. That the Conference confirms the principle that the Catalogue be published in the double form of cards and book.

11. That Schedules of Classification shall be authorized for the several branches of science which it is decided to include in the Catalogue.

12. That geography be defined as limited to mathematical and physical geography, and that political and general geography be excluded.

13. That anatomy be entered on the list as a separate subject.

14. That a separate schedule be provided for each of the following branches of science: Mathematics, Astronomy, Meteorology, Physics, Crystallography, Chemistry, Mineralogy, Geology (including Petrology), Geography—Mathematical and Physical, Paleontology, Anatomy, Zoology, Botany, Physiology (inclucing Pharmacology and Experimental Pathology), Bacteriology, Psychology and Anthropology.

15. That each of the sciences for which a separate schedule is provided shall be indicated by a symbol.

16. Professor Foster announced the reception of a letter from the German Chargé d'Affairs to the President of the Royal Society, stating that Geiheimer Regierungs-Rath Professor Dr. Klein, of Göttingen, had been appointed German Delegate to the Conference.

The regulations to be observed in the preparation of cards or slips were then taken into consideration, and it was resolved:

17. That Italian should be added to the list of languages not requiring translation.

18. That for each communication to be indexed at least one slip, to be called a *Primary Slip*, shall be prepared, on which shall be either printed or type-written or legibly handwritten in Roman script:

(i.) *Title-entries.*—The author's name and the full title of the communication, in the original language alone if the language be either English, French, German, Italian or Latin.

In the case of other languages the title shall be translated into English or such other of the above five languages as may be determined by the Collecting Bureau concerned; but in such case the original title shall be added, either in the original script or transliterated into Roman script.

The title shall be followed by every necessary reference, including the year of publication, and such other symbols as may be determined. In the case of a separately published book the place and year of publication and the number of pages, etc., shall be given.

(ii.) *Subject-entries*, indicating, as briefly as possible, the principal subjects to which the communication refers. Every effort

shall be made to restrict the number of these subject-entries.

Such subject-entries shall be given only in the original language of the communication if this be one of the five previously referred to, but in other cases in English or in such other language as has been used in translating the title.

[The Belgian delegates stated that they abstained from voting on the part of this resolution relating to subject-entries.]

SECOND MEETING, WEDNESDAY, OCTOBER 12.

19. Professor Korteweg having expressed the desire to be relieved of his office, it was resolved that Professor Weiss be appointed Secretary for the German language.

The following resolutions were adopted:

20. That the registration symbols used in the Catalogue be based on a convenient combined system of letters, numbers or other symbols, adapted in the case of each branch of science to its individual needs, and in accordance, as far as possible, with a general system of registration.

21. That the authoritative decision as to the Schedules be entrusted to an International Committee, to be hereafter nominated by this Conference.

22. That the Conference is of opinion that the delegates should be requested to take steps in their respective countries to organize local committees charged with the study of all questions relating to the International Catalogue of Scientific Literature, and to report within six months to the International Committee.

23. That the International Committee (Resolution 22) be instructed to frame a report, not later than July 31, 1899, which shall be issued by the Royal Society and incorporated in the decisions of the Conference.

24. That in all countries in which or wherever a Regional Bureau is established, as contemplated in the 16th resolution of the International Conference of 1896, the Regional Bureau shall be responsible for the preparation (in accordance with Reg. 7 of the Royal Society's Report) of the slips requisite for indexing all the scientific literature of the region, whatever be the language in which that literature may appear.

That each Regional Bureau shall transmit such slips to the Central Bureau as rapidly and as frequently as may be found convenient.

That in the case of countries in which no Regional Bureau is established, the Central Bureau, failing other arrangements, shall, upon special mandate, endeavor to undertake the work of a Regional Bureau.

[The Belgian delegates stated that they abstained from voting on this resolution.]

25. That the following recommendations of the Royal Society relating to the preparation of the Book Catalogue be referred to the International Committee for their favorable consideration, viz:

At determined regular intervals, not necessarily the same for all sciences, the Central Bureau shall compile from the slips and issue in a book form both an authors' and a subject-index of the literature published within that period.

This Book Catalogue shall be obtainable in parts corresponding to the several sciences for which slips are provided, and in such divisions of parts as may be hereafter determined.

In compiling the authors' index, in each of the sciences, the authors' names shall be arranged in alphabetical order, and each name shall be followed by the title of the paper and the necessary reference, and any other such symbols as may be determined.

The Book Subject Catalogue shall be compiled from the slips, as follows:

(i.) The subject-entries shall be grouped in sections corresponding to the registration letters on the slips, *i. e.*, to the several sciences.

(ii.) In each science the several subject-entries shall be arranged under headings corresponding to the registration numbers on the slips, the which headings and numbers shall be those contained in the authorized schedules of classification.

(iii.) The divisions indicated by registration numbers may be further subdivided by means of significant words or symbols.

(iv.) The nature of the subject entry may vary. Thus, as suggested in the cases of Mathematics and Physiology, it may be the title only; whilst in other sciences a special entry, more or less different from the title, may be provided on each slip. In all cases the number of subject-entries to be copied from a slip shall be determined by the number of registration numbers on the slip.

(v.) The mode of arranging subject-entries under a registration number, or under the subdivisions of a number afforded by significant words or symbols, may vary. They may either be arranged in the order of authors' names placed alphabetically, in which case the authors' names shall precede the subject-entry in the Book Catalogue, or they may be arranged either in an arbitrary order or in some order suited to the particular series of entries.

When in preparing an issue of the Book Catalogue it is found that a registration number has no entries collected under it the number and corresponding heading may be omitted from that issue.

To each part of the Book Catalogue corresponding to an authorized schedule there shall be appended an alphabetical index of the headings, and, if expedient, also of the significant words appearing in that part, showing on which page of the part each may be found.

After the publication of the first issue of the Book Catalogue the Director of the Central Bureau shall consult the Committees of Referees as to the desirability of making changes in the classification, and shall report thereon to the International Council, who shall have power to authorize such changes to be made as they may think expedient.

26. That the following recommendations of the Royal Society providing for International Conventions in connection with the Catalogue be adopted:

Each region in which a Regional Bureau is established, charged with the duty of preparing and transmitting slips to the Central Bureau for the compilation of the Catalogue, shall be called a 'constituent region.'

In 1905, in 1910, and every tenth year afterwards, an International Convention shall be held in London (in July) to reconsider, and, if necessary, revise the regulations for carrying out the work of the Catalogue authorized by the International Convention of 1898.

Such an International Convention shall consist of delegates appointed by the respective governments to represent the constituent regions, but no region shall be represented by more than three delegates.

The rules of procedure of each International Convention shall be the same as those of the International Convention of 1898.

The decisions of an International Convention shall remain in force until the next Convention meets.

27. That the following recommendations of the Royal Society relating to the constitution of an International Council, which shall be the governing body of the Catalogue, be adopted:

Each Regional Bureau shall appoint one person to serve as a member of a body to be called *The International Council*.

The International Council shall, within the regulations laid down by the International Convention, be the Governing Body of the Catalogue.

The International Council shall appoint its own Chairman and Secretary.

It shall meet in London once in three years at least, and at such other times as the Chairman, with the concurrence of five other members, may specially appoint.

It, shall, subject to the regulations laid down by the Convention, be the supreme authority for the consideration of and decision concerning all matters belonging to the Central Bureau.

It shall make a report of its doings, and submit a balance sheet, copies of which shall be distributed to the several Regional Bureaux, and published in some recognized periodical or periodicals, in each of the constituent regions.

28. That the following recommendations of the Royal Society relating to International Committees of Referees be referred for consideration to the International Council when constituted:

The International Council shall appoint for each science included in the Catalogue five persons skilled in that science, to form an International Committee of Referees, provided always that the Committee shall be as far as possible representative of the constituent regions. The members shall be appointed in such a way that one retires every year. Occasional vacancies shall be filled up by the Committee itself, subject to the approval of the Chairman of the International Council, and a member thus appointed shall hold office as long as the member whose place he fills would have held office.

It shall be the duty of the Director of the Central Bureau to consult the appropriate Committee or Committees, by correspondence or otherwise, on all questions of classification not provided for by the Catalogue Regulations; or, in cases of doubt, as to the meaning of those Regulations.

In any action touching classification the Director shall be guided by the written decision of a majority of the appropriate Committee or by a minute if the Committee meets.

Provided always that when any addition to or change of the schedule of classification in any one branch may seem likely to affect the schedule of classification of some other branch or branches, the Committees concerned shall have been consulted; and provided also that in all cases of want of agreement within or between the Committees, or of other difficulty, the matter shall have been referred for decision to the International Council.

All business transacted by the Committees shall be reported by the Director to the International Council at their next ensuing meeting.

THIRD MEETING, THURSDAY, OCTOBER 13.

The following resolutions were adopted:

29. That the Committee contemplated in Resolution 21 be constituted as follows: Professor Armstrong, Professor Descamps, Professor M. Foster, Dr. S. P. Langley, Professor Poincaré, Professor Rücker, Professor Waldeyer and Professor Weiss.

That this Committee be at liberty, if any of those named are unable to serve, to appoint substitutes, and also to co-opt two new members.

30. That the International Committee be termed the 'Provisional International Committee.'

31. That the Provisional International Committee shall be governed by the decisions of the Conference, but shall have the power of introducing such modifications in detail as may appear necessary.

32. Dr. Adler, referring to Resolution 20, said that he desired to place on record his view that the concluding words—"and in accordance, as far as possible, with a general system of registration"—the addition which he had agreed to as an amendment of his original Resolution, must not be re-

garded as modifying the first part of the Clause, or in any way throwing open the whole question of notation and classification.

33. Professor Rücker having made a statement as to the probable cost of the undertaking, and the delegates having stated what assistance in their opinion might be expected from their respective countries, it was resolved :

That the delegates to this Conference be requested to obtain information, and to report at any early date to the 'Provisional International Committee,' as to what assistance, by subscription or otherwise, towards the support of the Central Bureau may be expected from their respective countries.

34. M. Mascart called attention to Resolution 22 as being, in his opinion, incorrect in English, the intention being that the local Committee therein referred to should report to the International Committee.

35. The Royal Society was requested to undertake the editing, publication and distribution of a verbatim report of the Proceedings of the Conference.

36. It was resolved that the *procès verbal* of the Conference be signed by the President and Secretaries.

37. On the motion of Professor Armstrong, the thanks of the Conference were accorded to the Society of Antiquaries for the use of their rooms.

38. On the motion of Professor Klein, a vote of thanks to Sir John Gorst for presiding over the Conference, and his conduct in the chair, was passed by acclamation.

39. On the motion of M. Darboux, a vote of thanks was passed to the Royal Society for their work in preparation for the Conference and their cordial reception of the delegates.

(Signed) JOHN E. GORST, *President.*
HENRY E. ARMSTRONG,
H. LA FONTAINE,
E. WEISS, *Secretaries.*

CURRENT NOTES ON METEOROLOGY.

WEST INDIAN SERVICE OF THE WEATHER BUREAU.

THE *Monthly Weather Review* for July contains a paper by Professor E. B. Garriott on the West Indian Service of the United States Weather Bureau. The Service was undertaken under an Act of Congress approved July 7, 1898. Observations by regular observers of the Weather Bureau were begun at Kingston, Jamaica; Santo Domingo; St. Thomas; Port of Spain, Trinidad, and Willemstad, Curaçoa, on August 9th. Observations at Santiago were begun on August 11th, and at Bridgetown, Barbadoes, on August 31st. Regular reports have for some years been received from Havana, Cuba; Nassau, Bahamas, and Hamilton, Bermuda. The central station is at Kingston, and all other stations of the system cable daily, to Washington and to Kingston, reports of observations taken at 6 a. m. and 6 p. m., 75th meridian time. When the weather conditions are unusual, or there are signs of an approaching hurricane, special observations are telegraphed. Additional daily morning and evening reports are telegraphed to Washington via. Galveston, Texas, from Tampico, Vera Cruz and Coatzacoalas, and from Merida, Yucatan. Arrangements have been made for the prompt distribution of hurricane warnings from Washington to West Indian and Southern coast ports in the threatened district. The Service is at present an emergency service, but it is expected that, with the cooperation of the European governments having possessions in the West Indies, and of the countries bordering on the Gulf of Mexico and the Caribbean Sea, a permanent system of stations can be established, which shall permit the forecasting of hurricanes and northers, and shall carry out a study of the climatologic conditions of the West Indies.

ANTARCTIC METEOROLOGY.

The recent revival of interest in Antarctic exploration is a welcome sign to meteorologists, for Antarctic meteorology is in a sad state of incoherence and uncertainty. Our knowledge of the meteorological conditions of the Arctic is now in a fairly satisfactory state as compared with what we know of the sister zone around the South Pole. The October number of the *Scottish Geographical Magazine* is a 'Special Antarctic Number.' It contains reprints of Sir John Murray's address before the Royal Society, on 'The Scientific Advantages of an Antarctic Expedition,' with the remarks of Buchan, Neumayer and others made in connection with that address. Further, 'A History of Antarctic Discovery,' by the acting editor, and a most valuable Antarctic Bibliography, containing titles of publications bearing dates from 1761 to 1898, compiled by Bartholomew. A chart of the South Polar Region, after Sir John Murray's scheme for Antarctic exploration, presents, in small marginal charts, the mean temperature and the isobars and winds of the region in February. On the latter chart a considerable number of wind arrows (in red) are added to the observed wind directions (in black), in order to emphasize the hypothetical wind circulation around the South Pole. This hypothetical circulation is strongly anticyclonic in character. It remains to be seen, as the result of observation, how accurate this prediction is.

THE ASCENT OF ACONCAGUA.

The physiological effects of the diminished pressure at high altitudes, noted during the ascent of Aconcagua in 1896, are vividly described by Fitzgerald in *McClure's Magazine* for October. During the night spent at 16,000 feet one of the porters suffered terribly from nausea and faintness. At 18,700 feet Fitzgerald himself was completely used up. "It was very difficult to sleep more than a quarter of an hour or twenty minutes at a time without being awakened by a fit of choking." At 21,000 feet one of the porters was very ill, his face turning a greenish, livid hue. All the members of the party suffered from severe headache and mental depression, the usual symptoms of *soroche*. At 22,000 feet Fitzgerald was completely disabled, and was obliged to lie on his back, gasping for breath. He was so weak that he could not hold himself for more than a few paces at a time, and continually fell forward, cutting himself on the stones that covered the mountain side. The summit was reached by Zurbriggen, the Swiss guide, Fitzgerald himself being unable to continue the ascent owing to mountain sickness.

R. DeC. Ward.

Harvard University.

CURRENT NOTES ON ANTHROPOLOGY.

INDIAN GEOGRAPHIC NAMES.

Scattered over the map of the United States are many thousand local names derived from the various aboriginal dialects which were once spoken in the vicinities. In sound they are often harmonious and in meaning picturesque. It is a commendable curiosity which searches for this meaning, and also it is of ethnologic value, for sometimes these names are the chief or only evidence that the area where they occur was inhabited by some particular tribe or stock. A complete gazetteer of such would be most desirable, but the completion of such a task is a long way off.

One of the most diligent and capable students in the Algonquian geographic nomenclature is Mr. William Wallace Tooker. His latest publication on the subject is in the January number of the Publications of the Rhode Island Historical Society (Vol. V., No. 4). Its title is 'Indian Geographic Names, and why we should study them;

illustrated by some Rhode Island examples.' Its contents are well worth perusal and reflection.

THE MAYAN HIEROGLYPHICS.

IN the *Deutsche Literaturzeitung*, August, 1898, Dr. Ed. Seler gives what is intended to be a withering review of the 'Primer of Mayan Hieroglyphics,' written by me and published in 1895. It could hardly be expected that Dr. Seler should be pleasantly impressed on reading the book, for I felt constrained in various passages (pp. 83, 87, 89, 91, 92, 99, 112, 114, etc.) to point out the patent errors into which he had fallen, and how often he had adopted the Abbé Brasseur's views, always without acknowledgment of his French authority. He makes himself especially merry over what I explain (p. 24) as the 'cosmic sign,' representing the world as a whole in the pictography of the Mayas. Had he been really acquainted with the symbolism of native American art, as shown, for instance, by Professor Putnam and Dr. Willoughby in their model paper on the subject (Proc. Am. Assoc. Adv. Science, 1896), or as appreciated in the writings of such students as Mr. Cushing, Dr. Matthews and Miss Fletcher, he would probably have been less humorous, certainly less dogmatic and possibly more just.

COINCIDENCES.

UNDER this title Professor Max Müller has an article in the *Fortnightly Review* which he closes in these words: "I shall remain true to my conviction that all coincidences, whether in mythology, religion, art or literature, have a reason, if only we can find it."

It is evident from the examples in the article that the Professor means an objective reason, one from external suggestion, and that coincidences to him signify appropriations.

Of course, in a certain percentage of cases this is so, and nobody would deny it; but in another and large percentage it is not so. The coincidences are due to independent mental evolution along the same lines, under the impulse of the same desires. This is true in all four of the fields named by the essayist, as well as others; and it is perhaps the most significant discovery in modern ethnology. That Professor Max Müller has refused to accept it is the reason why his vast labors on Comparative Religion have exerted such incommensurate influence on anthropologic science.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC NOTES AND NEWS.

A MONUMENT to Pasteur was unveiled, if the arrangements were carried out, at Lille, on November 5th, an oration in memory of Pasteur being made by M. Duclaux.

THE University of Vienna will place in the hall of the University a bust of Dr. Müller, whose life was sacrificed in attending the laboratory servant Barisch, infected with the plague in Professor Nothnagel's laboratory.

THE Royal University of Ireland has conferred its honorary D.Sc. on Mr. Thomas Preston, the physicist.

DR. T. H. BEAN has recently spent a month in making collections of fishes along the southern shore of Long Island, in the interest of the U. S. Fish Commission.

A VACANCY in the position of Marine Meteorologist, Mare Island Navy Yard, California, will be filled by a civil service examination on December 6th.

WE record with much regret the death of Dr. James I. Peck, assistant professor of biology in Williams College and Assistant Director of the Marine Biological Laboratory at Woods Holl. We hope to give in a subsequent issue some account of Dr. Peck's life and work. His untimely death is a serious loss to zoology and will be deplored by many friends.

THE death is announced of Dr. David A. Wells, the eminent writer on economics. It is, perhaps, not well known that he began his

career as a scientific author, to which, perhaps, may be attributed, in part at least, the valuable character of his work in economics. After graduating from Williams College, Wells entered the Lawrence Scientific School at Harvard as a special pupil of Louis Agassiz, and was subsequently lecturer on physics and chemistry at Groton Academy, Mass. At Cambridge, in 1849, he began, with George Bliss, the publication of *The Annual of Scientific Discovery*, which was continued until 1886. In 1856 he invented valuable improvements in the method of manufacturing textile fabrics. He also compiled several scientific text-books, including 'Science of Common Things,' 'Elements of Natural Philosophy,' 'Principles and Applications of Chemistry' and 'First Principles of Geology.'

We are compelled also to record the death of Professor George Vestal, professor of agriculture and horticulture at the New Mexico Agricultural College, on October 24th, aged 41 years; of Dr. W. Kochs, docent for physiology at Bonn, and of M. J. V. Barbier, a well-known French geographer.

Dr. H. F. Moore, of the United States Fish Commission, has been making a careful examination of the physical conditions of Great Salt Lake, with a view to determine its adaptability to oysters and other salt-water and brackish-water animals. While it is known that the salinity of the open lake is so great as to preclude the possibility of the acclimatization of useful marine animals, it has been suggested that there are certain bays or arms of the lake, in which rivers discharge, where the density is lowered to a point somewhat less than that of ocean water, and where it may be possible for clams, oysters, crabs, terrapins and such animals to survive and multiply. Dr. Moore has not completed his inquiries, but it may be said that the outlook for an augmentation of the aquatic food resources of this region is not very promising, the amount of fresh water entering the lake being subject to great variation, and the existence of a natural food supply for the introduced species being uncertain. For a number of years people living near the lake have from time to time importuned the Fish Commission to make experimental plants of fish and other animals in the lake and its tributary streams. Considerable numbers of young shad have been deposited in the rivers, but there is no evidence of their survival. The present inquiries will, it is thought, definitely settle the question.

Mr. Axel Danielson, of Stockholm, writes to the *Scientific American* in regard to the status of the Nobel bequest. He says that the case has been decided, or rather a compromise has been effected between the contesting parties. The relatives of the deceased will receive 3,800,000 Swedish crowns, a little more than $1,000,000, so that there still remains for the prizes the sum of 25,000,000 crowns, equivalent to $6,950,000. The income, computed at the rate of three per cent., will make the five prizes worth 150,000 crowns, or $41,600 each. It is expected that the compound interest during the time, which will necessarily be long, that will elapse before the prizes can be awarded will increase the capital so as to cover the cost of managing the funds and the work entailed in properly distributing the prizes. It will be remembered that these prizes are to be awarded annually to persons making the most important discoveries in physics, chemistry, physiology or medicine. There is also to be a prize for the best literary contribution upon the subject of physiology or medicine, and also one for any person who has achieved the most or done the best things looking toward the promotion of the cause of peace throughout the world.

The New York *Evening Post* learns from the *Berlingske Tidende* that the first competition offered by the Nansen fund, which was established soon after the return of the Fram in 1896, has just been advertised. The subject is a thorough work in embryology based on original investigation, and the amount of the prize is 1,500 kroners (about $400). The result will be announced at the annual meeting of the Christiania Academy of Science, May 3, 1900.

The German Colonial Council has requested the government to provide, as soon as possible, stations for agricultural experiments in German Southwest Africa and to establish a service for meteorological observations extending over the entire territory.

M. HENRI LECONTE made an address before the Paris Society of Commercial Geography on October 20th, on the colonial botanical gardens of France, in which he called attention to their inadequate support by the State. The total amount spent on these gardens is said to be only half as much as that given to the Dutch garden at Buitenzorg, and the results are small in proportion. M. Guy, representing the Minister of the Colonies, stated after the address that a commission would shortly be formed to study the administration of the experimental botanical gardens in the colonies.

THE Imperial Russian Geographical Society has decided to establish a Seismological Station at Irkutsk.

A CABLEGRAM to the London *Times* states that Sir John Forrest, Premier of Western Australia, has received a report from Sir Frederick McCoy, professor of natural science in the University of Melbourne, stating that his examination of fossils from the seams of the Collie coalfield, in Western Australia, shows that the deposit is of exactly the same geological age as the Newcastle coalfield, in New South Wales. He adds that the specimens of coal examined are equal to the best Newcastle coal. Professor McCoy congratulates the Premier on the discovery of this magnificent addition to the natural wealth of the colony.

CARNEGIE Library, at Homestead, Pa., was dedicated on November 6th by the founder, Mr. Andrew Carnegie, who spent $300,000 in its erection.

THE National Educational Association will meet next year at Los Angeles, if favorable railway rates can be secured.

THE New England Association of Chemistry Teachers meets at the United States Hotel, Boston, to-morrow evening. Dr. H. M. Goodwin is the guest of the Association and will give 'An Address on Some Aspects of Physical Chemistry.' The President of the Association, Dr. Lyman C. Newell, will make a preliminary report on the progress of the movement instituted by the Association to promote efficiency in the teaching of chemistry.

THE fifth International Congress of Hydrology, Climatology and Geology met at Liege from the 25th of September to the 3d of October.

THE Royal Geographical Society, London, will open its session on November 14th, when the meeting will be devoted mainly to a national Antarctic expedition. The President, Sir Clements Markham, will introduce the subject, and will be followed by other distinguished scientific men. The Society has just issued an appeal for funds for a national expedition. At the second meeting, on November 28th, Mr. C. W. Andrews will give an account of the interesting results of his year's investigations on lonely Christmas Island. Other papers that are expected are 'Explorations on the Caroline Islands,' by Mr. F. W. Christian; 'Explorations among the Canadian Rockies,' by Dr. Norman Colley, F.R.S.; 'Explorations in Sokotra,' by Dr. H. O. Forbes; 'Lake Rukwa and Central Africa,' by Mr. L. A. Wallace; and papers by Dr. J. W. Gregory and Professor W. M. Davis, of Harvard University.

ON October 25th an international monument in honor of Dr. Hans Wilhelm Meyer, the discoverer of adenoid growths, was unveiled in Copenhagen. The *British Medical Journal* states that the memorial, which is a bronze bust of more than life-size resting upon a granite base, stands in the Gefion Square, in East Copenhagen. It is the work of the Danish artists, Bissen and Runeberg. The Mayor of Copenhagen, several high officers of state and a number of professors of the medical faculty, of medical men and of the general public were present at the ceremony. The memorial was formally handed over to the municipality of Copenhagen by Sir Felix Semon, who delivered an address in which he pointed out the importance of Meyer's discovery, which had already saved thousands of people from life-long deafness and the lasting results of obstructed nasal respiration, and in future times would be similarly beneficial to hundreds of thousands and even to millions. He described Wilhelm Meyer as one of the greatest benefactors to mankind that the profession of medicine had ever known. After the monument was unveiled, M. Ollgaard accepted it on behalf of the City of Copenhagen.

Reuter's agency reports that the German archæologist Professor Belck was attacked, wounded and robbed by Kurdish marauders in the Sipan Dagh while separated from his escort. As the result of representations immediately made by the German embassy, the Sultan gave orders for the most rigorous pursuit and the punishment of the guilty parties. The perpetrators of the outrage have now been discovered and arrested. The property and a part of the money stolen have been recovered. In accordance with directions personally given by the Sultan, Herr Belck will receive every attention at the cost of the State. He is now at Van, still under medical treatment, but out of danger.

The Swedish scientific expedition to the Klondike, under the conduct of Dr. Otto Nordenskjöld, is now on its way home, and is expected to arrive in London about the end of the month. The expedition has been exploring since March last, and the results are expected to be of considerable interest.

An expedition is about to leave England to investigate and make collections of the fauna of the island of Sokotra, situated eastward from Cape Guardafui. The party, consisting of Mr. W. R. Ogilvie Grant, of the Department of Zoology of the Natural History Museum; Dr. H. O. Forbes, the Director, and Mr. Cutmore, Taxidermist of the Liverpool Museums, will be conveyed from Aden by a steamship furnished by the British government. The Royal Society, the Royal Geographical Society and the British Association have made appropriations towards the expenses of the expedition.

It is still an open question whether the fauna of the sea is confined to belts near the surface and the bottom, or whether the intermediate zones are inhabited. To investigate this problem a deep-sea expedition has been organized, as we learn from the London *Times*, through grants by the Royal Geographical Society, the Draper's Company and the Fishmonger's Company, and has been placed under the direction of Mr. George Murray, Keeper of the Botanical Department of the Natural History Museum. The trustees of the British Museum have helped by granting Mr. Murray the necessary leave of absence and lending him the services of two of the Museum naturalists, Mr. V. H. Blackman and Dr. Gregory. Mr. J. E. S. Moore, Dr. Sambon and Mr. Highly, of whom the last is an artist, complete the staff of the expedition. The steamship *Oceana* has been chartered and is being fitted with its deep-sea gear by the kindness of the Silvertown Telegraph Cable Company. The steamer was expected to be ready by November 5th, when it would proceed directly to the west coast of Ireland. Work will begin at the edge of the 100-fathom platform, about thirty miles west of Dingle Bay. The vessel will steam slowly for 10° westward. Continuous observations will be made with a vertical chain of tow nets, the length of which will be gradually increased until, when the depth of 2,000 fathoms is reached, the series will include thirty-eight tow-nets. Soundings and observations of temperatures will be made, and, if time permit, some deep-sea trawling. Experiments with various forms of self-closing nets, including the Tanner net employed by Professor Agassiz, will be made for the sake of comparison; but the main effort of the expedition is to determine the vertical distribution of oceanic life by a series of open nets.

We learn from the *Philadelphia Medical Journal* that the State Legislature of Vermont has passed an Act providing for the equipment and maintenance of a State laboratory which shall include in its work 'the chemical and bacteriological examination of water-supplies, milk and all food-products, and the examination of cases, and suspected cases, of diphtheria, typhoid fever, tuberculosis, malaria and other infectious and contagious diseases.' The sum of $5,000 has been appropriated for the establishment of the laboratory, and $8,000 per year voted for running expenses. Dr. J. H. Linsley is director of the laboratory. It appears that only three States have established similar laboratories—Michigan, Massachusetts and New York.

UNIVERSITY AND EDUCATIONAL NEWS.

The University of Cincinnati has again been presented with a gift of $60,000, this time by Mr. Asa van Wormer, a retired merchant of

Cincinnati. This sum is to be devoted to the erection of a fire-proof library building. As the University is the custodian of the library of the American Association for the Advancement of Science, this gift will have an added interest.

THE sum of $40,000 has been secured toward the erection of the new physiological laboratories of the University of Pennsylvania, but the plans and estimates for the buildings have not yet been decided upon.

THE Board of Estimate and Apportionment of New York City has allowed over $13,000,000 for education, an increase of more than one million dollars over the expenditures of the present year. The increase is chiefly for new teachers and for increasing the salaries of those teachers who are now paid the least. It is satisfactory to note that the expenditure for education is the largest item in the budget of Greater New York and that the increase is twice as great as in any other direction. It is expected that in January bonds will be issued to defray the cost of the erection of new school buildings.

ON the 28th of October the north wing of the recently erected 'Mechanic Arts Hall' was opened with appropriate ceremonies by the University of Nebraska. Professor Morgan Brooks, who succeeds Professor Robert B. Owens as the head of the department of electrical engineering, gave his inaugural address, 'Electricity and Enlightenment.' Regent Morrill, of the Building Committee, reported the completion of the building, a substantial brick structure of modern construction, four stories in height and containing thirty rooms. Chancellor MacLean, in a brief address, dedicated it to the uses of the Industrial College, whose Dean, Dr. Charles E. Bessey, pledged the Commonwealth of Nebraska that the building should be used 'to promote that education of the people contemplated by the Act of Congress which founded the College.' Governor Holcomb unveiled a commemorative tablet, and in the course of his remarks expressed the hope that in the not-distant future there might be enough buildings on the campus to accommodate 5,000 students. A formal address in the evening by President Chaplin, of Washington University, with brief congratulatory addresses and letters, closed the exercises.

AN international commission of architects has recently examined at Antwerp the plans submitted for reconstructing the buildings of the University of California in competition for the prizes offered by Mrs. Phœbe Hearst. One hundred and eight plans were submitted and of these eleven were selected for prizes, each of which was $1,200. The final plan will be selected by a jury after visiting the site of the University.

THE summer school at Cornell University has been reorganized, being made a more integral part of the University and being arranged with special reference to the needs of high school teachers. Instruction will next summer be given by leading members of the faculty, including Professors De Garmo, Titchener, Atkinson, Bailey, Comstock, Roberts, Caldwell, Tarr and Fish.

THE faculty of the University of Chicago seems to contain an unusually large number of former college presidents and prospective college presidents. The presidency of Oberlin College has just been offered to Professor J. H. Barrows and the presidency of the University of Cincinnati to Professor Edmund James.

DISCUSSION AND CORRESPONDENCE.

FISH OVA FOR EDUCATIONAL PURPOSES.

THROUGH the medium of SCIENCE I desire to announce that during the fall, winter and spring months the United States Fish Commission will, on request, gratuitously supply educational institutions with living fertilized eggs of the various marine and fresh-water fishes cultivated at the government hatcheries in different parts of the country. The eggs of about twenty species can be regularly furnished from as many stations, several kinds of eggs being handled at most of the hatcheries.

The eggs can be sent in lots of 500 or 1,000, and will usually arrive at their destination in good condition. Most of the eggs available during the colder months are those of salmonoid fishes which are susceptible of shipment over long distances, when placed in layers on trays with wet cloth-bottoms, packed in sphagnum and crated. Salmon and trout eggs so packed

have been safely sent from this country to Europe, Asia and Australia. Eggs of marine species are shipped in tightly-closed jars containing water, and may be expected to arrive with not more than 50 per cent. loss at points that may be reached in twenty-four to thirty hours. Shad and pike-perch eggs do not stand distant shipment well unless accompanied by an attendant, but may be sent unattended short distances (covered in ten hours or less) either on trays or in cans containing water. Trout and salmon eggs are not likely to survive long shipments except immediately after fertilization and after becoming 'eyed.'

Some of the places at which hatcheries of the Commission are located, the kind of eggs available at each station, and the approximate period when they can be supplied, are as follows:

Woods Hole, Mass.—Cod, Nov. 15 to Jan. 30; flatfish, Feb. and March; lobsters, April to June.

Gloucester, Mass.—Cod, Dec. 1 to Feb.; pollock, Nov. and Dec.

East Orland, Me.—Atlantic salmon, Oct. to Feb.

Green Lake, Me.—Brook trout, Nov. to Feb.; landlocked salmon, Nov. to Feb.; golden trout, Nov. and Dec.; lake trout, Nov. to Feb.

St. Johnsbury, Vt.—Brook trout, Oct. to Jan.

Washington, D. C.; Havre de Grace, Md., and Gloucester, N. J.—Shad, April 15 to June 1.

Wytheville, Va.—Rainbow trout, Dec. to Feb.

Erwin, Tenn.—Brook trout, Nov. and Dec.

Put-in Bay, Ohio.—Whitefish, Dec. 1 to Feb. 1; lake herring, Dec. and Jan.; pike perch, April.

Northville, Mich.—Lake trout, Oct. to Jan.; brook trout, Nov. to Jan.; Scotch lake trout, Nov. to Jan.

Duluth, Minn.—Lake trout, Oct. to Feb.

Manchester, Iowa.—Brook trout, Nov. to Jan.; lake trout, Nov. to Jan.

Neosho, Mo.—Rainbow trout, Dec. and Jan.

Bozeman, Mont.—Grayling, June; black-spotted trout, June.

Leadville, Colo.—Brook trout, Oct. to Jan. 30; black-spotted trout, June; rainbow trout, June; Scotch lake trout, Oct. and Nov.

Baird, Cal.—Quinnat salmon, Aug., Sept., Dec. and Jan.

Clackamas, Oregon.—Quinnat salmon, Nov. 1 to Feb. 1.

When eggs other than those regularly handled by the Commission are desired, an attempt will be made to obtain them.

Persons intending to take advantage of this opportunity should, in order to save time, communicate directly with the superintendent of the nearest station at which the desired eggs are being developed, informing him definitely regarding the number and kind of eggs wanted, the time when they are to be sent, the addresses to which they are to go, and the dates, if any, on which subsequent lots are to be shipped. The transportation companies will receive full instructions from the Commission as to the care of the eggs during shipment, and should also be asked by the consignees to make special efforts for prompt delivery.

The Commission has from time to time furnished fish eggs in response to special requests. The fact that a few universities and colleges have asked for eggs suggests that other institutions may desire such material. The only expenses to be incurred are the charges for transportation and the cost of special packing boxes; the latter item is small and may be rendered comparatively insignificant by the return of the empty boxes to the various stations in case additional consignments of eggs are requested.

Hugh M. Smith.

U. S. Commission of Fish and Fisheries.

On a Suitable Name for the New Planet.

To the Editor of Science: The unique character and singular orbital position of the little planet *DQ*, recently discovered by Mr. G. Witt, give the question of its nomenclature more interest than usually attaches to such matters. Of course, the selection of a name, by courtesy and the precedent of custom, must be left to the taste and discretion of the discoverer. But it is trusted that he will pardon suggestion with regard to it, since it is a matter that other astronomers may take a legitimate interest in.

It is manifest that this little object is destined to play a rôle in our astronomy of very great importance. It opens up, at a stroke, an unexpected and royal road to the problem of the solar parallax, as well as to the nutation, the moon's mass and the aberration. Melancholy as the statement may be, it will reduce many of the existing discussions of these elements to the value of waste paper, records of futile effort.

Prominent as the object is thus likely to become, it deserves a good name. I would suggest that of Pluto, and desire to urge the claims of this gentleman to the distinction. He is the only one, of the six children of Saturn whom that unnatural father was unsuccessful in eating or otherwise destroying, who has not yet stood as godfather or godmother to some member of our planetary system. The other five, Jupiter, Neptune, Ceres, Vesta and Juno, have been worthily assigned, either to major planets or to the earlier discovered members of the Mars-Jupiter belt of asteroids. For the use of the later discoveries in this numerous group the list of available female goddesses has long since been exhausted, and now sweethearts, wives, girl-babies, and even provinces, cities and towns, are jumbled together in our lists of these objects in a ludicrous way. Will it not assist to a slight return to dignity and sanity of nomenclature to give some of the neglected male gods a chance, and destroy the unfair monopoly of the *beau sexe* in such matters? This seems a good time to begin. The body in question stands apart from the Mars-Jupiter belt, practically a stunted twin of Mars himself. Moreover, there is a certain fitness in the appellation arising from its faintness or invisibility on ordinary occasions. Pluto, under his older name, Hades, was the 'invisible' or 'unknown,' the God of Darkness. This invisibility he removes, with the helmet forged for his concealment by Vulcan, when he comes to perihelion opposition, shining then as a comparatively bright star, perhaps visible to the naked eye. This helmet, by the way, could serve as his conventional planetary symbol, if one is desired.

The addition of new asteroids to our lists has become such a nuisance that ordinarily the attachment of ridiculous names may be regarded as one of the helpful influences in discouraging further useless multiplication of these troublesome wards of astronomy. But when one is born into the solar system which gives promise of paying for its keep, some attention should be devoted to a proper christening. In the solution of the problems I have indicated, Pluto may be counted on to pay handsomely for his board and clothes.

It is hoped that the discoverer will take these considerations, and others which could be urged, into account in his selection of a suitable name for this interesting and important little object.

S. C. CHANDLER.

CAMBRIDGE, October 31, 1898.

THE MINOR PLANET DQ.

THE notice in *Nature*, September 29th, quoted in SCIENCE, October 14th, seems to indicate a misunderstanding in reference to the orbit of the new minor planet DQ, by implying that it lies wholly within that of Mars. This is not the case; while the perihelion distance of the new planet is about 23,000,000 miles less than that of Mars, or only 12,500,000 miles greater than the mean distance of the earth, the eccentricity of its orbit is such that its aphelion distance is 37,300,000 miles greater than the perihelion distance of Mars, or nearly 10,800,000 miles greater than the aphelion distance of Mars. The periodic time of the new planet is only 643.7 days, or 1.76 years. The periods of all the other asteroids lie between 3.0 and 8.4 years.

The above numbers are derived from the elements of the orbit of DQ which I have computed from observations embracing an interval of 43 days. These elements confirm the results of Dr. Berberich.

W. J. HUSSEY.

LICK OBSERVATORY, October 27, 1898.

THE STRESS-STRAIN RELATIONS OF RUBBER.

IN the issue of SCIENCE of November 19, 1897, is a very interesting article by Professor Thurston upon the singular stress-strain relations of rubber, accompanied by the strain diagram for the same. This curve shows very clearly the peculiar and sudden increase in the value of the ratio of the stress to the strain as the point of rupture is approached.

It seems to the writer that this form of curve is to be expected as the result of the peculiar microscopic and physical constitution of rubber. It is well established that rubber consists of a mixture of two modifications of the same substance, one hard and fibrous and the other soft and viscous. These are identical in composition and similar in general properties and reactions. In other words, rubber consists of a

matrix of soft viscous matter with hard fibres imbedded and interlaced in all directions.

If this physical constitution of rubber is granted, it is clear that its elasticity must be due to the hard fibrous component, and that, therefore, these hard fibres are elastic.

If now the rubber be subjected to stress, the resistance at the beginning of the strain will be due to the forced change of shape of the individual elastic fibres, the bent ones being straightened and *vice versa*. As the strain becomes greater, however, the fibres are drawn out longitudinally and the applied force is less and less opposed by the resistance to change of shape of the fibres, and more and more opposed by their direct tension. In the extreme case, where the fibres are supposed straightened out lengthwise of the specimen, the resistance will be almost wholly due to the direct tensile strength of the fibres and the cohesion between them.

The action may be likened to that which occurs with a spiral spring. Thus, when the spring is first subjected to stress it opposes the applied force wholly by the resistance to change of shape of the wire, but later, when the stress becomes so great as to draw out the spiral, it acts less by its resistance to change of shape and more by virtue of its direct tensile strength. Finally, when the wire has become straight, its resistance is entirely a function of the tensile strength. Of course, in the rubber there are no fibres extending the length of the specimen, but consisting, as it does, of a network of imbedded and interlaced elastic fibres, it acts, in opposing the stress, like the spiral spring, first, by the resistance to change of shape of the fibres, and later by their cohesion and resistance to direct stress. That the action in the two cases is similar may be inferred from a comparison of the stress-strain diagram of the rubber given by Professor Thurston, with the data of the accompanying table of tests upon a spiral spring of one-fourth-inch diameter and one-inch length:

Load (lbs.).	Elongation (inches).
1	1
2	2.7
3	9.2
4	14.7
5	16.7
6	17.7
7	18.2
8	18.65
9	18 95
10	19.19
11	19.38
12	19.51

These data will plot a curve very much resembling the corresponding diagram for the rubber, and showing the same peculiar increase of the ratio of the stress to the strain.

Perhaps a better illustration of the supposed action would be given by the stress-strain relations of a chain with circular links. Here, after the links are flattened out by the stress, the applied force is opposed entirely by the direct tensile strength of the material, while in the early stages of the strain it is mainly opposed by the resistance to change of shape of the links.

It seems to the writer that some such simple explanation of the phenomena of the stress-strain relations of rubber naturally suggests itself from what is known of its physical constitution.

C. M. Broomall.

Media, Pa., October 17, 1898.

[On reference to our columns, in issues of February 19th and April 15th, our correspondent will find that Professor Fessenden some years ago (See *Jour. Frank. Inst.*, September, 1896) offered this same interpretation of the singular behavior of this peculiar substance, and has, furthermore, furnished experimental illustration of artificial reproduction of the phenomena described by Dr. Thurston. The comparison between the data for the rubber and for the helical steel spring, here given, is interesting also; but it is to be observed that the rubber finds an elastic limit only at its point of rupture, while the steel exhibits a change of law on passing an elastic limit far within that limit, usually if not always, and it certainly is not composed of such a mixture of 'hard and horn-like substance with jelly-like matter in its pores,' as is described by Fessenden. Experimental investigation must still be continued in order to reveal the secret of this curious exception to the ordinary behavior of materials of construction and of commerce.—Ed. Science.]

THE LOWER SONORAN COCHINEAL.

IT is well known to residents and travellers in the Southwest that the cacti of that region furnish a kind of cochineal, but whether it was identical with the commercial insect long remained in doubt. The purpose of the present note is to separate and define the Lower Sonoran form, which has hitherto remained nameless. Four kinds of cochineal have came to my notice, as follows:

(1) *Coccus cacti*, L., of tropical Mexico and southward. The type locality is Surinam.

(2) *Coccus tomentosus*, Lam. (*opuntiæ*, Licht.) of the Mexican tableland south of the Tropic of Cancer.

(3) *Coccus tomentosus* subsp. *newsteadi*, subsp. nov.' of the Lower Sonoran in Arizona, Texas and northern Mexico.

(4) *Coccus tomentosus* subsp. *confusus*, Ckll., of the Upper Sonoran in New Mexico and Colorado.

The subsp. *newsteadi* was first described by Mr. R. Newstead in the *Entomologists' Monthly Magazine*, April, 1897, pp. 75–76, from specimens imported to Kew Gardens on *Opuntia fulgida* from Arizona. He intended at first to name it as distinct, but finally treated it as *tomentosus*. It is a fair intermediate between *tomentosus* and *confusus*, both structurally and geographically. It has the spines and glands about as in *tomentosus*, but averages smaller, with the antennæ usually 6-segmented, and the cottony secretion abundant, much as in *confusus*. It occurs in Wabash Creek Cañon, near Flagstaff, Arizona (*Ehrhorn*), La Puerta Rancho, in Tamaulipas (*Townsend*), Point Isabel, Texas *Townsend*), etc.

There is no probability that either *newsteadi* or *confusus* can be used commercially. (See Bull. 3, Tech. Sec., Div. Ent., Dept. Agriculture, p. 35.)

T. D. A. COCKERELL.

MESILLA PARK, N. M., October 8, 1898.

THE ENDOWMENT OF AMERICAN ARCHÆOLOGY.

TO THE EDITOR OF SCIENCE: I should like to make a suggestion through SCIENCE to all the universities and organized societies of the United States that a strong and systematic effort be made to celebrate that point in the age of the world called the year 2000 A. D. by a fund of $2,000,000, whose interest would be devoted to a study of the archæology of America. The money and the willingness to give and to use it are in plenty, and among scientific needs there is nothing that can compare. The splendid monuments of antiquity, rapidly fading away, especially in Mexico, Central America and Peru, offer the greatest rewards.

Two strong expeditions or parties ought to be kept in the field constantly. A committee of the schools and colleges should plan the work systematically, and arrange a method for making results accessible to all the public, by descriptions, models, photographs, etc. The suggestion is respectfully submitted.

W. S. PROSSER.

AUBURN, CAL.

THE SENSE OF SOLIDITY.

TO THE EDITOR OF SCIENCE: Having had frequently the following experience, I record it with the hope that it may call forth either analogous experiences from others or some explanation.

On falling asleep with any weight in my arms I have noticed that on waking at a certain stage of drowsiness the feeling of solidity has entirely vanished. It is not only that the sensation of weight is very much dulled, but the sense of continuity in the held body is gone. Indeed, it often seems as if the hole between the parts whose contact is actually experienced could be felt. The contrast with ordinary experience is so great that it serves to bring out very effectually the fact that ordinarily in holding an object we have not only a sense of contact and of weight, but also a sense of 'filling-in,' of tactile solidity or continuous extension. In the experience referred to, the contact sensations also appear to have a granular rather than a continuous character.

JOHN DEWEY.

UNIVERSITY OF CHICAGO,
October 21, 1898.

SCIENTIFIC LITERATURE.

The Free Expansion of Gases. Edited by J. S. AMES, PH.D. Scientific Memoirs. New York, Harper & Brothers.

A few months ago the pleasing announcement

was made that the publication of a series of 'Scientific Memoirs' would shortly be commenced by Harper & Brothers, under the editorial direction of Professor Ames, of Johns Hopkins University. They were to relate mostly to physical science, and were to include only memoirs of first importance, and generally only such as are not very easy of access, or which are found only in some language other than English, or in a form otherwise inconvenient. Professor Ames has secured the editorial assistance of a number of well-known students of physical science, and it is gratifying to know that in the near future many of the most important memoirs relating to this great department of human knowledge, many of which have marked epochs in the history of science, will be available in a convenient and comparatively inexpensive form.

The plan will now be better understood after an examination of the first volume of the series, which bears the title given above and is edited by Professor Ames himself. It is a very attractive-looking octavo of about one hundred pages. A preface of one page is followed by Gay-Lussac's paper, read at the Institute on September 15, 1807, on a 'First Attempt to Determine the Changes in Temperature which Gases experience owing to Changes of Density, and Considerations on their Capacity for Heat.' This is an extremely interesting and important memoir, not hitherto easily accessible, although it was reprinted in Leipzig in 1896. Its principal interest is in the evidence of Gay-Lussac's anticipation of some of the most important conclusions of Joule and Thomson, which they worked out with great skill and originality nearly half a century later. Twenty years ago and earlier there was much bitter controversy over the credit due Mayer for his share in the development of the principle of the Conservation of Energy. The importance of his work is greatly enhanced by the recognition of his acquaintance with Gay-Lussac's experiments, which, says Professor Ames, is now generally admitted.

This memoir is followed by a paper upon the same subject, published in 1845, and by several others on the Thermal Effects of Fluids in Motion, the joint work of Joule and Thomson. These constitute the most important literature on the subject and have been the foundation of the modern thermodynamics.

The editor, while adhering closely to the original, has found condensation necessary and possible in portions of the reproduction. Brief biographical sketches of Gay-Lussac and Joule are given, and, when the interest which always attaches to the personality of men who do great things is considered, it seems a pity that a page or two was not given to each of these, instead of a brief paragraph. The mere dates of birth and death, and such like, are not usually the most interesting facts relating to a human life.

This and other volumes of the series soon to appear will undoubtedly meet with a hearty welcome, for they will make it easy for all students to possess the essence of what is of the very highest importance in the literature of exact science, either current or classic.

M.

Thermodynamics of the Steam-Engine and Other Heat-Engines. By Cecil H. Peabody, Professor of Marine Engineering and Naval Architecture, Massachusetts Institute of Technology, Boston, Massachusetts. New York, J. Wiley & Sons; London, Chapman & Hall. 4th ed. Rewritten and reset 8vo. Pp. 522. Price, $5.00.

This is a new and revised, rearranged and extended issue of the well-known work of Professor Peabody, now ten years old. The book has been carefully and completely revised, to bring it up to date in theory and in current practice. Considerable new matter has been introduced and the whole has been reconstructed in such a manner as to make it substantially such as its author would have prepared as a new treatise on its subject at the present time. It is an excellent piece of technical work and undoubtedly will more than sustain the reputation which it has already acquired. This volume is a standard treatise on Clausiusian thermodynamics in our technical schools and among engineers, and, so far as the reviewer is informed, the only treatise of that school which presents any satisfactory discussion of applied thermodynamics having value for the engineer engaged in professional work relating to the heat-en-

gines. It is a practitioner's and student's text-book in that system, as Wood's Thermodynamics is the representative for the same classes of readers of the Rankinian method.

In the new book a considerable addition has been made to the discussion of the gas-engines, which includes the latest information regarding producer-gas and the oil-engines, and closes with a discussion of the Diesel motor, now attracting, deservedly, much attention among members of the engineering profession as having attained unusual results by an exceptionally successful attempt to reproduce ideal thermodynamic conditions in an approximation to the Carnot cycle. Its best work is reported at 223 grms. of petroleum per hour for 19.2 horse-power, equal to three-fourths of a pound of coal per horse-power-hour. The best steam-engines, even of many times this power, consume seldom less than double this figure. The latter half of book is devoted mainly to the subjects of steam-engine testing, compound and other multiple-cylinder engines, the influence of the cooling effect of cylinder-walls and steam-engine economy generally. Considerable new matter appears in these sections. The latest investigations, as those of Hall, and of Callendar and Nicholson, are detailed, with admirable success in condensation. Recent and notable reports on steam-engine trials, as of the famous engines of Leavitt and of Sulzer, of Schmidt and of Rockwood, and of the steam-turbines, are summarized and the data are tabulated. The more elaborate scientific tests of the 'experimental engines' of the Massachusetts Institute of Technology and of Sibley College at Cornell University are presented in their essential details, while the discussions exhibiting the ideal and the real effects of the operations of compounding, of superheating and of jacketing, as influencing efficiency and economy of steam, heat and fuel, are most instructive and valuable. The final chapters are devoted to brief discussions of compressed-air machines and apparatus of refrigeration.

This book is a rarely good work and is excellently published. It is one which no member of the engineering profession dealing with the heat-engines can safely leave out of the list of his working library, and no student desiring more than a superficial knowledge of its subject should fail to read with special care.

R. H. THURSTON.

Prismoidal Formulæ and Earthwork. By THOMAS U. TAYLOR, Professor of Applied Mathematics in the University of Texas. New York, John Wiley & Sons. 8vo. Pp. 102 and one plate. Price, $1.50.

The historical and theoretical discussions of this volume will be of especial interest and value to civil engineers on account of the extensive use of the prismoidal formula made by them in earthwork calculations and because the engineering handbooks generally avoid such discussions. There are probably few engineers who know that the prismoidal formula is applicable to the volume of a sphere, or to any segment of a sphere, as also to ellipsoids and paraboloids. The author shows that its application is wider even than this, and that the volume of any prismoid whose sectional area can be expressed by a cubic function of its distance from any reference section is found by adding the areas of the two bases to four times the area of the mid-section and multiplying this sum by one-sixth of the length. He also gives demonstrations of the two-term prismoidal formulas of Koppe, Hirsch and Echols, and discusses their limitations and uses in a very interesting manner. Although these two-term formulas involve but two sections instead of three, it does not appear that they are more convenient in practice than the common formula.

The author attributes to Newton the honor of the discovery of the prismoidal formula, and states that it is given in the Methodus Differentialis, 1711. An examination of this paper of Newton fails, however, to substantiate this statement, and it is to be regretted that the author did not quote the words in which he claims that the theorem was announced. His reference to Simpson is also unsatisfactory, although he points out that Simpson's rule for the quadrature of a curve from three ordinates is the same in form as the prismoidal formula. With these exceptions the historical matter of the volume is more complete than can be easily found elsewhere. Over one-half of the book is devoted

to computations for excavations and embankments of railroads and canals, and the method of using the prismoidal formula by means of corrections applied to the volumes as determined from average end areas is developed at length. It is to be regretted that the author uses the Latin word formulæ instead of the English word formulas. M. M.

SCIENTIFIC JOURNALS.

Botanical Gazette, October: Mr. J. H. Schaffner, in a paper on 'Karyokinesis in the root tips of *Allium Cepa*,' states that he finds the root tips of *Allium Cepa* very valuable objects for the study of nuclear division. The details he illustrates upon two handsome plates, because, he says, "accounts and figures of karyokinesis in plant cells are very scarce, and the so-called diagramatic or schematic figures and descriptions given in most text-books are but a poor guide for the student and young investigator." A student of Mr. Schaffner's, Mr. Edward L. Fulmer, writes on the 'Cell division in pine seedlings,' illustrating the process by two plates. Mrs. Fannie D. Bergen continues, in two installments, her list of 'Popular American Plant Names.' These papers are reprinted from the *Journal of American Folk Lore*. Dr. Byron D. Halsted has a short discussion of the newer aspects of botany, especially the ecological ones. The paper summarizes some remarks before the National Educational Association at Washington. Dr. C. F. Millspaugh contributes 'Notes and new species of the genus *Euphorbia*,' illustrated by his admirable figures. A biography of Joseph F. Joor, with portrait, and a short sketch of the DeCandolle family are written respectively by Mr. J. B. S. Norton, of the Missouri Botanical Garden, and Dr. G. E. Stone, of the Massachusetts Agricultural College. Mr. Clarence J. Elmore has studied the question of polyembryony in certain wild species of *Allium*. He finds the contents of the embryo sac exceedingly variable, the frequent absence of antipodals being especially noteworthy. In Open Letters, Dr. Robinson disavows responsibility for 'The American Botanist,' which was dated without authorization from the Gray herbarium; and Mr. Cockerell has a short letter on the nomenclature of *Eschscholtzia Mexicana* and *Philibertella heterophylla*. Reviews are given of Barnes's 'Plant Life;' Britton and Brown's 'Illustrated Flora,' volume three; 'The Ninth Report of the Missouri Botanical Garden;' part two of Durand and Schinz's 'Flora of Africa;' Courchet's 'Text-book of Botany,' and Schneider's 'Guide to the Study of Lichens.' Twelve pages of Minor Notices of books and papers, Notes for Students, and News complete an unusually varied number.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON—295TH REGULAR MEETING, SATURDAY, OCT. 22.

Dr. T. S. Palmer mentioned the reported occurrence in Patagonia of a living representative of the extinct Mylodons.

Mr. G. H. Hicks exhibited specimens of *Pinus torreyanus* and spoke of its extremely restricted distribution.

Dr. J. N. Rose presented a paper on his 'Proposed Arrangement of the subfamily Agaveæ,' stating that it was partly based on his four months' study of the group in its home in Mexico. The paper, which was illustrated by specimens, photographs and drawings, was particularly interesting from the fact that living types of all the genera were shown.

Mr. F. A. Lucas spoke on 'The Fossil Bison of North America, with description of a new species' for which the name *Bison occidentalis* was proposed. The horn cores of this species were of moderate size, although much larger than those of the existing species; their circumference at base was equal to, or slightly greater than, length along upper curve; they were sub-cylindrical in section and regularly curved upward and backward. The type from Fort Yukon was No. 4047 of the collections of the U. S. National Museum. The species was readily distinguished from *B. antiquus*, with which it had been confounded by the fact that in *antiquus* the horns stood at right angles to the longitudinal axis of the skull and were not directed backwards.

Mr. A. J. Pieters read a paper on 'Problems of Aquatic Vegetation,' stating that aquatic plants, especially the unicellular algæ, are the primary source of food supply in the lakes. The relation between the higher plants and the low

forms that feed on them are but imperfectly understood, although we know that millions of minute animals and plants make a home among *Characeæ*, *Naias* and other phanerogams.

The effect of the growth and decay of the larger plants upon the algæ is probably of much importance, but definite information is wanting. Our conception of the relation between the phanerogams, the medium in which they grow, and the bottom may be somewhat changed if the experiments of Hochreutener on the flora af Lake Geneva can be confirmed. He found that the species studied absorbed eosin solution much more readily by their roots than by their leaves. If this proves to be true the study of bottom samples will be more important than before.

The most important problem in fresh-water algology is the study of the rate of growth of unicellular forms, and all the questions necessarily connected with this.

Specimens were shown that illustrated the effect of depth and local conditions of environment on the habit of species. Rootstocks, tubers and bulbs were shown and attention was called to their importance in the questions concerning the propagation and reproduction of aquatics.

Mr. Gilbert H. Hicks read a paper on 'The Effect of Certain Fertilizers on the Germination of Seeds.' Attention was called to the losses which often result in practical farm operations from the failure to secure a 'stand' of certain crops, due to the excessive or improper use of chemical fertilizers which often prevent or retard the germination of the seeds.

The paper was based upon experiments conducted in one of the greenhouses of the Department of Agriculture upon seeds of wheat, lettuce, radish and crimson clover. In one series of greenhouse 'flats' seeds were planted in rows directly in contact with the chemical; in another series the upper stratum of soil was mixed with the same amount of chemical used in the previous case and the seeds were planted in this stratum; otherwise the conditions of growth were exactly the same. Checks were also conducted at the same time. The plant food elements—nitrogen, potash, phosphoric acid and lime—were used in the forms of nitrate of soda, muriate of potash, dissolved bone black and powdered oyster shells. In addition to these a 'balanced' fertilizer, consisting of a mixture of the above ingredients, was employed.

The experiments proved to be of much interest and appeared to warrant the following conclusions:

1. That muriate of potash and sodium nitrate used as fertilzers in strengths of one per cent. or more are very detrimental to the germination of seeds, whether applied directly or mixed with the soil.

2. That fertilizers composed of phosphoric acid or lime are much less injurious to germination than sodium nitrate or muriate of potash, and if not used in excess may be harmless.

3. That commercial fertilizers should not be brought into direct contact with germinating seeds.

4. The effect of treating seeds with chemicals before planting is no index to the action of those chemicals when applied as manures to the soil.

5. That the chief injury to germination from chemical fertilizers is effected upon the young sprouts after they leave the seed coat and before they emerge from the soil, while the seeds themselves are injured only slightly or not at all.

6. It is highly improbable that potash, phosphoric acid, nitrogen or lime used as fertilizers actually favor germination.

F. A. LUCAS,
Secretary.

BIOLOGICAL SECTION, NEW YORK ACADEMY OF SCIENCES—MEETING OF OCTOBER 10, 1898.

IN the absence of Professor Wilson, Professor Osborn in the chair.

Professor Osborn referred to the loss sustained by the Academy and the biological sciences in general through the death of Professor Baur, of Chicago, and Dr. Arnold Graf, of New York.

Following the usual custom, the meeting was devoted to reports given by various members of their summer's work.

Professor Osborn described the different museums which he visited in Europe, giving a brief account of the good and bad points of each. At Stuttgart he saw a unique and undescribed fossil, *Hyrax*, which Professor Fraas very generously gave him the pleasure of describing. The

description was presented at the meeting of the British Association in Cambridge.

Professor Osborn was followed by Professor Britton, who gave a *résumé* of the work accomplished during the summer on the building and grounds at the Botanic Garden in Bronx Park.

Professor Dean reported on a few results on the embryology of the Hag Fish, which he thinks is similar to that of the shark. He also described the appearance of a Central African Lung Fish (*Protopterus*), which was sent to him in a ball of dried mud.

Dr. O. S. Strong and Mr. H. E. Crampton reported briefly of the nature of the work accomplished at the Marine Biological Laboratory at Woods Holl, bringing out particularly the fact of the cordial relations between the Fish Commission investigators and those of the Laboratory.

Mr. N. R. Harrington related some interesting experiences in connection with his expedition to the Nile valley in quest of *Polypterus bishir*. The expedition, which was made possible by the generosity of Mr. Chas. H. Senff, was undertaken by Mr. Harrington and Dr. Reid Hunt. As guests of the Egyptian government they enjoyed unusual advantages in securing their ends, but only after repeated trials and discomforts and many disappointments did they finally get the fish.

Other brief reports were made by Professor Lloyd (on the botanic gardens of Germany), Dr. Brockway and Mr. Calkins.

GARY N. CALKINS,
Secretary of Section.

GEOLOGICAL CONFERENCE OF HARVARD UNIVERSITY, OCTOBER 11, 1898.

MR. A. W. GRABAU opened the work for the year with a paper on 'Some Methods of Stratigraphical Field-work.' He illustrated practical suggestions on collecting fossils and measuring sections by cases drawn from his detailed study of the Eighteen Mile Creek section, New York. Mr. J. R. Healy described the features studied by the Harvard mining class during its summer visit to the Lake Superior mining region. The party examined the underground workings of thirteen mines, and the open-cut workings in the extensive iron-ore deposits of the Mesabi Range.

OCTOBER 18, 1898.

DR. F. P. GULLIVER delivered a paper on the 'Physiography of the Ural Mountains, and illustrated it with numerous lantern views. The Great Plain of Russia, a plain of denudation, rises gently and constantly from the center of the country into the Urals. It has been traced upon the folded and faulted Devonian strata of the outer ranges, and also upon the more intensely plicated Carboniferous beds and upon the granite of the Central Urals. In addition to this, Dr. Gulliver observed remnants of peneplains at two other distinct levels. The relative attitudes of these levels indicate, first, that the Ural Mountains have been elevated as a whole in the form of an arch with a north-south axis; and second, that this elevation, and the dissection consequent upon it, occurred in at least three distinct stages.

The physiographic features noted on the western side of the continental divide are repeated on the eastern side, with the addition of a steep fall-off from the Ilmen Mountains to the great Siberian peneplain. Richtofen holds that this is a sea scarp cut by the same sea that carved the Siberian plain. Others believe that it is a fault scarp which marks the disjointing of the Siberian plain from one of the upper levels of the Urals.

J. M. BOUTWELL,
Recording Secretary pro tempore.

NEW BOOKS.

The Psychology of Peoples and its Influence on Their Evolution. New York, The Macmillan Company. 1898. Pp. xii + 236.

The Fishes of North and Middle America. DAVID STARR JORDAN and BARTON W. EVERMANN. Washington, Government Printing Office. 1898. Part 4. Pp. xxx + from 1241–2183.

Laboratory Exercise in Anatomy and Physiology. JAMES EDWARD PEABODY. New York, Henry Holt & Co. 1898. Pp. x + 79.

Observations of the Planet Mars during the Opposition of 1894–95, made at Flagstaff, Arizona. PERCIVAL LOWELL. Annals of the Lowell Observatory, Vol I. Boston and New York, Houghton, Mifflin & Co. 1898. Pp. xi + 391.